Qualitative evaluation of a self-management system for shift workers working in healthcare

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Master Thesis

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2018-09-24

To all that made me who I am,
but, specially, to my younger sister,

Abstract

Smart technologies have been an ally of value creation improvement in service provision. To address the challenges and issues faced by shift workers who work in the healthcare sector, a self-management system has been developed, aiming to support the everyday lives of middle-aged to older shift workers.

This study aimed at performing a qualitative evaluation of the developed system. To achieve that purpose, an 8-week pilot was conducted with five healthcare professionals who used the system. Following the tenets of Grounded Theory methodology, complemented with a Service Design approach, 18 semi-structured interviews were planned and conducted with healthcare professionals from CUF Hospital. The recorded interviews were transcribed verbatim to be analysed and coded using Scrivener software.

Results suggest that there is still room for system improvement. Although sleep records were not always accurate, the participants were still able to learn about their sleep routine. The same is not applicable to the activity information, a feature that most of the participants felt that did not correspond to reality, suggesting some improvements. In regards to the light exposure, a problem regarding sensor orientation was found, which skews the collected data to almost non-existent light.

Future work will focus on developing a set of recommendations for system improvement in a way that enables to increase self-awareness in shift workers and promote their engagement with the system.

Resumo

As tecnologias inteligentes têm sido um aliado na melhoria da criação de valor na prestação de serviços. Para abordar os desafios e as questões enfrentadas pelos trabalhadores por turnos que trabalham no sector da saúde, foi desenvolvido um sistema de autogestão com o objectivo de apoiar o quotidiano de trabalhadores por turnos de meia-idade a idosos.

Este estudo teve como objectivo avaliar qualitativamente o sistema desenvolvido. Para atingir esse objectivo, foi realizado um piloto de 8 semanas com cinco profissionais de saúde, que usaram o sistema. Seguindo os princípios da Grounded Theory, complementados por uma abordagem de Desenho de Serviços, foram planeadas e conduzidas 18 entrevistas semi-estruturadas, com profissionais de saúde do Hospital CUF. As entrevistas gravadas foram transcritas na íntegra para serem analisadas e codificadas usando o software Scrivener. Os resultados sugerem que ainda há espaço para melhorias no sistema. Embora nem sempre os registos do sono fossem precisos, os participantes eram capazes de aprender sobre a sua rotina de sono. O mesmo não se aplica às informações da actividade, uma característica que a maioria dos participantes achou que não correspondia à realidade, sugerindo algumas melhorias. No que diz respeito à exposição à luz, foi encontrado um problema relacionado com a orientação do sensor, o que distorce os dados recolhidos para luz quase inexistente.

O trabalho futuro reside no desenvolvimento de um conjunto de recomendações para melhoria com vista a aumentar a autoconsciência nos trabalhadores por turnos e promover o seu envolvimento com o sistema.

Acknowledgements

I want to start thanking my supervisor from Faculty of Engineering, Professor Lia Patrício, for providing me her precious insights on Service Design that would always light up my mind each time I met her for clarifying any doubts.

To my supervisor at Fraunhofer, Doctor Francisco Nunes, I truly thank him for all the advices. He demonstrated to be a very sensitive and honest person, who was very comprehensive and always had time to listen to me whenever I had a doubt or a concern to share. It was a very pleasant experience to work at Fraunhofer facilities, with such a friendly group of people.

I also want to thank my fellow trainees (Catarina, Inês, João and Nuno), for being such good partners, both during the work, where we shared knowledge and opinions, and during our breaks, where they were an enjoyable company to me.

Moving to a personal sphere, I want to eternalize my deep gratitude to my best friend, Maria João Monteiro, and her parents, Mrs. Emília Rocha and Mr. João Monteiro, for having provided me a home and a family, when my real family was falling apart. During eight months, they represented the support I needed for finishing my studies, making me part of their everyday lives. My heartfelt thanks for all the effort that you have done, that I cannot thank enough by these words.

Besides my friend and her family, I have special thanks to my beloved Ricardo Ventura, who has been the most affectionate and patient person in my life. I am really glad that we share now a home. Thank you for your unconditional love and for all the support, not only throughout this thesis, but in general in my life.

Finally, but not the least, it would not be possible to achieve the results of this thesis without the collaboration of the participants who engaged in the research study. Thank you for making your time available for me, even when you already have such few time for your personal stuff.

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1. Introduction

According Sarwar and Soomro, "there is no doubt that smartphones are brining great features and capabilities to consumer" and "the enormous usage of these devices by consumers" demonstrates its impact (Sarwar and Soomro, 2013, p. 223-224). Despite the increased availability of smartphones and health applications (apps), Kratzke et. al say that little is known about smartphone technology and apps for implementation in health promotion practice" (Kratzke, Cynthia; Cox, 2012). Therefore, it is essential for health promotion professionals to understand how to use smartphones and apps in health interventions (Kratzke, Cynthia; Cox, 2012).

This work studied whether a smartphone application could help healthcare professionals improve their circadian rhythms and, consequently, their own experience of working in shifts. To understand the shift workers' experience, it was studied the shift workers' journey. A qualitative evaluation of the system was performed with 5 shift workers, aiming at understanding how these professionals used and appropriated the developed system, which barriers they found for using the application, and what drove them to use it.

This was complemented with the analysis of existing interviews, which took place before the system's development, for understanding these professionals, their context and their practices.

This way, it would be possible to understand the challenges and issues faced by shift workers and evaluate if they were being addressed by the system.

This research study also allowed to define recommendations for improvement of the system, which helps to complete and enrich the evaluation that was performed.

1.1 Project background

Shift work is becoming a prevalent work arrangement in contemporary society. Data from 2016 show that more than 18% of the European population work in shifts, a number that has raised around 0.2% each year, since 2009 (Eurostat, 2018). According to Eurofound[1], this represents a strong increase since previous decades (Eurofound, 2016). The major concern regarding this growth is that shift work is associated with negative outcomes that range from complications in balancing work and personal life to the feeling of health and safety being at higher risk (Eurofound, 2016).

1 Eurofound is the European Union Agency for the improvement of living and working conditions (Eurofound, 2017a).

According to the same survey, people report that they feel more exhausted and predict that they will not be able to work until 60 years old (Eurofound, 2016).
Shift work is often framed as a risk for many diseases, including sleep disorders, cancer, gastrointestinal and neuropsychological pathologies (Harrington, 2001; Knutsson, 2003; Costa, 2010; Richter *et al.*, 2010; Saberi and Moravveji, 2010; Medic, Wille and Hemels, 2017; Sagah Zadeh *et al.*, 2017). From this set of diseases, sleep disruption has been the main concern in the literature, as it has adverse consequences, that "may be just as damaging as those of short sleep duration" (Medic, Wille and Hemels, 2017). Those consequences may consist of risks of developing other diseases "including cancer, neurodegenerative diseases, metabolic disorders and inflammation" (Ibáñez, 2017, p. 05).
Shift work is such a harmful working arrangement that the International Classification of Sleep Disorders has officially defined the Shift Work Sleep Disorder. (Costa, 2010).
However, and despite the negative characteristics of shift work, we cannot avoid it. The reason why we cannot avoid shift work is that, both in the case of healthcare and security, there is the need for 24 hours coverage. Healthcare deals with the health and safety of human beings, who usually are suffering from any illness and are feeling sick or painful. Caring for people is not a work one can interrupt or let halfway. In the case of security, some buildings require to be guarded by someone day and night, to avoid thievery. Machinery is a too expensive resource to invest on. Therefore, people is the only existing resource to work in these places that require continuous activity.
Once we cannot avoid shift work, Fraunhofer Portugal AICOS, a research center for *Assistive Information and Communication Solutions*, wants to make shift work the best it can be, bearing in mind the inherent conditions that we cannot eliminate. As a research center, Fraunhofer Portugal AICOS (from now on, Fraunhofer) conducts applied research and development to create technological solutions, based on end-user's insights (Fraunhofer Portugal AICOS, 2018). In this pursuing, Fraunhofer is coordinating a project that intends to "shape technology to support and improve the lives of shift workers in the healthcare setting" (Fraunhofer Portugal AICOS, no date, p.02). To do so, they developed a solution - the Clockwork system - through which they provide personal data to these professionals, hoping it will raise awareness about their own working and sleeping routines. Ultimately, this might enable healthcare professionals to change lifestyle habits, what can possibly improve their quality of life.

1.2 Problem Description

There is a variety of technological devices for sleep and fitness tracking. "Popular trackers, such as the Fitbit One, include a sleep mode that aims to provide sleep time and restlessness"

(Sleep Health Foundation, 2015). In regards of their portability, sleep trackers are either wearable or non-wearable devices. But in this particular case, it was desirable to have a wearable device that could accompany the professionals along their shifts, so that sleep and activity could be monitored while they were working. In the context of healthcare, though, professionals are not allowed to use accessories in their wrists, like bracelets or even wristwatches. Since healthcare professionals have specific antiseptic rules, they cannot use existing solutions for sleep and activity monitoring at work.

To address this challenge of monitoring personal parameters without compromising the antiseptic rules that healthcare sector encompasses, Fraunhofer researchers started the Clockwork project, where they gathered, through user research and co-design, valuable information on the issues and challenges faced by shift workers in healthcare and their practices to cope with sleepiness at work. With the collected information, Fraunhofer developed the Clockwork system, along with its partners.

The Clockwork system is composed by:

(1) **a Smart Badge** that senses movement activity and captures light exposure while at work; it replaces the original card case where shift workers place their identification card,

Image 1 - *Clockwork smart badge*

(2) **a box** that collects environmental data about light, noise, and temperature,

(3) and **a smartphone application** (**Image 2**) that also captures the movement activity, especially when professionals are not working, displaying graphics that give them a picture of their day in terms of sleep, physical effort and light exposure (transmitted by the badge's sensor) (*Clockwork*, 2018).

Image 2 - *Initial screen of the Clockwork application*

In regards to the personal data that the solution provides, shift workers can consult the number of sleeping hours per day, level of activity in each shift and percentage of light exposure per shift. The objective of showing the number of hours that one sleeps is to raise awareness on the real sleep routines, which will enable the participants to verify if they are getting less or more sleep than what they think they usually do. The fact that the solution provides data about light exposure is something that might promote some reflection on the working conditions and in the way that professionals can regulate its intensity or not.

With these insights, the Clockwork team expects that shift workers can have more control over themselves and that it will empower them to manage their lifestyle in a way that makes them feel healthier and happier.

Being the solution created, the aim of this master thesis was to perform a qualitative evaluation of the technology-enabled service introduced with the Clockwork system, through the understanding of how shift workers use and appropriate it and what is the impact it causes.

1.3 Research Questions

To follow-up the precedents of the Clockwork project and to promote a more robust final analysis, this study addressed the understanding of the shift workers' context in healthcare by answering:

1. How do shift workers manage their shift work?
   - What are their challenges?
   - What are their strategies to deal with these?

This research question regards the understanding of the professional's point of view of their experience as professionals who work in shifts, enabling to gain a more in-depth notion of what these professionals need, want and what are the main issues they face.

Afterwards, to address the evaluation of the Clockwork system, the aim of this master thesis was to answer:

2. How do shift workers experience the Clockwork system?
   - How they appropriate the system in their everyday activities and work setting?
   - What are the main barriers and drivers for its usage?
   - What is the impact of Clockwork on the experience of shift workers?

1.4 Study and Project Development at Fraunhofer Portugal AICOS

The study was organized in two main phases, one focusing on the pre-development of the Clockwork system and another one focusing on the post-development of it.

The first phase was more exploratory, looking forward to finding any characteristics of shift work - positive or negative -, and the practices used by shift workers to cope with them.

The second phase comprised the study of shift workers' experience with the Clockwork system, aiming at understanding how they used the system in their benefit and how it fitted in their everyday life, both at home, while managing their personal life, as well as in their working shifts, while managing their effort and alertness at work.

With this set of information, this dissertation intends to generate suggestions for improvement of the Clockwork system, in a way that represents the views of the participants, fulfilling the needs and concerns they conveyed.

The research study followed a qualitative approach, with the goal of understanding what practices shift workers carry out to cope with their atypical working schedules while trying to balance their own health and well-being with their personal and social life.

In this qualitative research study, there were conducted eighteen semi-structured interviews with a theoretical sample of five participants from CUF Porto Hospital and CUF Descobertas Hospital, which consists of the health partner of the project. Participants were of two distinct

functions, orderlies[2] and nurses, which allowed to gather different perspectives on the routines within work at the hospital. This was particularly useful to guarantee that we would cover all the practices, regardless the job function, enabling a more complete picture of shift workers' experience.

1.5 Report outline

This thesis is structured in 6 chapters.

The first one (1) introduces the problem that led to this research study, presenting the project background and problem description. It comprises the problems associated with shift work in healthcare, objectives for this study and the contribution one might expect for this master thesis.

To achieve the expected results, the second chapter (2) provides a picture of the related work regarding shift work studies, moving then to the Customer Experience and Service Design frameworks for a more holistic representation of the shift workers' experience.

The chosen methodology appears in chapter five (3). Here, the research design is described, explaining the procedures that were performed to achieve the results of this thesis. Ethical concerns also take place in this chapter.

Chapter six (4) presents and describes the obtained results, providing an overview on the participants' testimonies. Followed by a chapter for discussion (5), reflecting on the contribution of the findings compared to what has been already studied.

Finally, there is a chapter with the conclusions and future research (6) where the research questions are approached, and future work is identified.

2 Orderly is an attendant who does routine, nonmedical work in a hospital.
Source: orderly. (n.d.) The American Heritage® Medical Dictionary. (2007). Retrieved September 5 2018 from https://medical-dictionary.thefreedictionary.com/orderly

2 Literature review

To understand what had been done in the literature, it was made a search over existing works on shift work. In addition, to better study the shift workers' experience, Customer Experience and Service Design approaches were also searched for.

2.1 Predominance of shift work in Society

Shift work is becoming increasingly prevalent in contemporary life (Smith *et al.*, 1999). Today's percentage of shift workers in the European Union are above 18% of the population. Among this working arrangement, alternating or rotating shifts are the predominant types of shift, followed by the permanent ones (mornings, afternoons or nights) (Eurofound, 2016).

Through a quick overview on Eurostat, we can notice that the countries with the smaller rates of shift work are France, Belgium and Denmark, ranging from 6,5% to 9% in the last year. In contrast, Montenegro appears as the country with the highest rates, having reached almost half of the population working in shifts in 2013 and currently presenting a percentage of around 36% (Eurostat, 2018). If shift work has dropped down in Montenegro in the last years, in Portugal it increased 3,5% only from 2010 to 2011. From then to today's percentage, it also raised more 3% (Eurostat, 2018), which represents a big increase overall.

While differences in the proportions by gender are small (Eurofound, 2016), shifts can vary significantly across countries and industries (Lozano-Kühne, J. P. et. al, 2012), being the most prevailing industry the health sector, representing 40% of the shift work (Eurofound, 2016).

Accordingly, the sixth EWCS found a significant representation of health workers, that along with transport, construction and agriculture sectors, compose a percentage of 26% of the European workers who have less than the minimum daily rest period recommended by the Working Time Directive (11 hours). Surprisingly, it seems to be a choice of some of those people, as this percentage includes self-employed workers (Eurofound, 2017).

2.2 Sleep disruption and circadian rhythms

According to Gerstner and Yin (2010), cited by (Ibáñez, 2017) sleep "is vital for normal brain function and circadian dysfunction has been linked to sleep disorders, as well as depression, bipolar disorder, cognitive function, memory formation and some neurological diseases".

The circadian rhythm is an "an internal biological clock that anticipates day/night cycles", helping people to "optimize their physiology and behaviour" (Ibáñez, 2017), by regulating sleep patterns, feeding behaviour, hormone release, blood pressure and body temperature (**Figure 1**) (Smith, Carlla S.; Reilly, Christopher; Midkiff, 1989; Ibáñez, 2017). This internal clock then reflects on people's mood, alertness, drowsiness and task performance (Smith, Carlla S.; Reilly,

Christopher; Midkiff, 1989). Therefore, it is because of this internal clock that we feel sleepy at some point of the day.

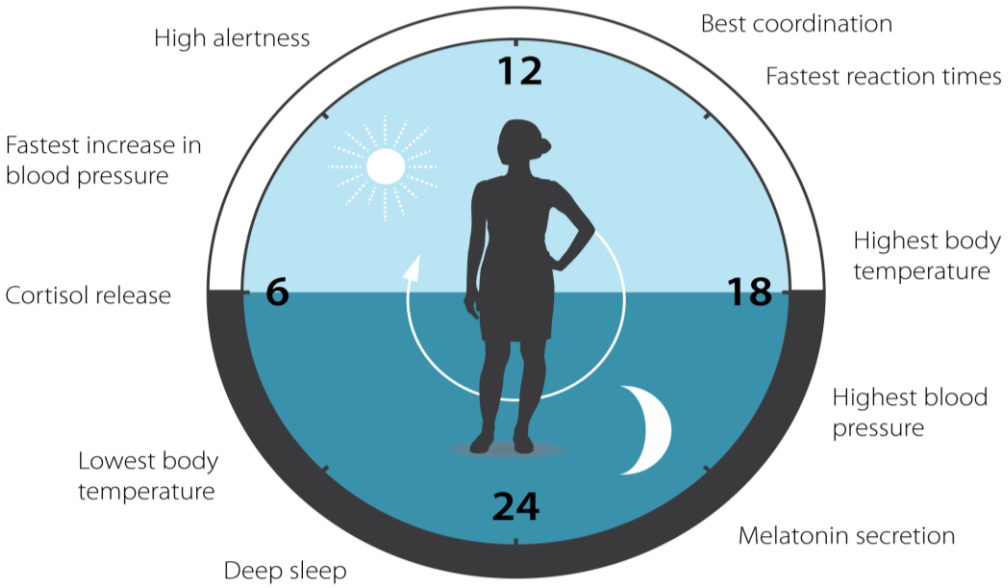

Figure 1 - *Representation of our internal biological clock* (Ibáñez, 2017, p.5)

A descriptive study from 2011 on sleep and environmental factors found that 64% of their night shift respondents felt their sleep was affected by environmental factors. They complained mostly about noise, but bright lightning, warm temperature, uncomfortable sleeping areas and not being used to sleep during the day also had negative impact (Lozano-Kühne, J. P. et. al, 2012).

As mentioned in the beginning of this topic, night shift workers face desynchronization between their circadian rhythms and ambient synchronizers. This happens due to the inversion of their sleep-wake cycle (Prata, Isabel and Silva, 2013). Therefore, besides the feeling of dissatisfaction, caused by the lack of sleep, or poor quality of it (Lozano-Kühne, J. P. et. al, 2012), health risks are on the way for a long-term future (Ibáñez, 2017; McHill and Wright, 2017).

2.3 Effects on health and well-being

Shift work is responsible for a panoply of negative impacts. Symptoms like fatigue, jetlag, gastrointestinal issues, obesity and sleep disturbances are common among shift workers, as opposed to day workers (Harrington, 2001; Eurofound, 2016, 2017). Shift workers also have an excess risk (40%) for cardiovascular diseases compared with the general population. Myocardial infarction is also associated with shift work, as shown by a study of 334 cases and

there are reports that indicate a significant increase in occurrence of neoplasms in shift workers (Knutsson, 2003). In the Philippines, musculoskeletal ailments usually involve the neck, upper back, lower back, right shoulder, upper right arm, hand and wrist. It's also very common to hear complaints about coughing, insomnia, the eyes and the voice (Lozano-Kühne, J. P. et. al, 2012). The detrimental effect shift work can have in sleeping and/or waking hours has become a big concern in the literature (Smith *et al.*, 1999; Lozano-Kühne, J. P. et. al, 2012). The detrimental effect shift work can have in sleeping and/or waking hours has become a big concern in the literature (Smith *et al.*, 1999; Lozano-Kühne, Jingky P.; Aguila, Maria Eliza R.; Manalang, Gayline F.; Chua, Richard Bryann; Gabud, Roselyn S.; Mendoza, 2012).

2.4 Effects on private and social life

Unfortunately, problems of shift work do not restrict to health issues. Shift work also triggers disruptions in social and family life (Smith *et al.*, 1999). People that have professions with atypical working schedules face a desynchronization between their responsibilities and the general rhythms of the rest of the society (Costa, 1997). Moreover, the fact that shit workers of them don't have a regular schedule hampers the possibility of establishing family routines, with the addition that shift work encompasses work during weekends, which makes it difficult to attend some cultural and recreational events and activities (Costa, 1997). Due to constraints of organizing time, shift workers struggle to find times when they and their friends are available (Costa, 1997). People who work in shifts are often asked about the possibility of being together more regularly, when the fact is that they already spent their active hours working during the night, and then have the need to rest, sleep and have their personal duties. Here is when an advantage is found by these workers, which is the opportunity to "use daytime hours to comply with private needs" (Novak and Auvil-Novak, 1996), such as access to public offices, bank, etc.

2.5 Strategies for coping with working schedules

Different studies, from healthcare design or workplace psychology, point out behavioural and organizational practices for coping with sleepiness at work and increasing alertness. Among those practices are certain light conditions, mini rests and naps, which have been tested (Sagah Zadeh *et al.*, 2017).

2.5.1 Managing Sleep-Wake Routine

A research in Ohio, on the effects of coping strategies, social support and *work - non work* conflict on shift workers' health, reported that all of the participants have had their sleep

modified, because shift workers found it difficult to sleep during the day. Most of the participants shared that they tried to sleep once they got home. Unfortunately, not everyone could immediately fall asleep. While some of the participants accepted the consequence, taking the opportunity to interact with family or spend time doing other activities, most of the nurses tried to reduce the external light by using draperies or window blinds. Besides this, fans and radios appear as a peculiar strategy in chasing sleep, as it produces what some people call "white noise" (Novak and Auvil-Novak, 1996). Besides these strategies to help sleeping, shift workers could better recover from night work if they took naps during the working shift, up to two hours (Palermo *et al.*, 2015).

2.5.2 Light Exposure

Another study regarding employees' wellness in healthcare, reports that more than 50% of the participants spent less than a quarter of the day in natural lighting while working. Worse than this is the fact that over 40% of the surveyed professionals didn't even observe sunlight the whole day (Trau *et al.*, 2016). Nevertheless, the literature states that seeking for daylight is not a popular strategy among night-shift workers, as they don't find it executable and that technology can be used to simulate daylight (Sagah Zadeh *et al.*, 2017).

2.5.3 Physical Exercise

Research studies point that day shift employees are more involved in physical activities than night shift workers (Lozano-Kühne, J. P. et. al, 2012). In agreement with this, the Ohio study also had feedback on how nurses reduced their usual exercise activities, referring that it is harder to arrange time to exercise while working, except if workers choose to walk during the mealtime instead of eating, which turned out to be a strategy of increasing their vigilance and alertness (Novak and Auvil-Novak, 1996).

2.5.4 Food Patterns

Due to the atypical working hours, shift workers have to modify meal schedules (Costa, 1997). In regards of eating habits, an interesting approach found in the literature was "meal splitting". This strategy consists of eating half of a portion when doing a meal break in a night shift, leaving the other half for a later snack as a way of reducing sleepiness after eating (Novak and Auvil-Novak, 1996).

Again, on the Ohio research, no participant reported to consume alcohol or medications to improve the quality of their day sleep (Novak and Auvil-Novak, 1996). Instead, food appears

as a strategy for maintaining alertness, with the help of "the three c's" for caffeine, which are coffee, cola, and chocolate. Despite the apparent benefit, caffeine might impair sleep time after work. And that is the reason the more experienced nurses didn't rely on caffeine (Novak and Auvil-Novak, 1996).

2.5.6 Education on shift work

The need for education seems to be consensual among the research. On a focus group for evaluating nurse shift work difficulties, researchers found out that nurses had never had recommendations regarding sleep hygiene, neither in their academic or professional training. Therefore, learning occurred in a more individual basis, being provided the advice of more experienced co-workers. In this case, the problem is that each person is different and not every tip fits another person, which forces people to try advice and see the result. The same professionals would later refer that, for that reason, it would be useful having an in-service program or pamphlet with coping strategies (Novak and Auvil-Novak, 1996).

Concerning the comprehension of the adaptation process regarding shift work, and bearing in mind the role organizational context can play, studies show that when shifts are selected by the workers, these tend to manifest a higher degree of adaptation to said shifts (Pisarski, Bohle and Callan, 1998; Silva, Prata and Ferreira, 2014); there is also a tendency for these choices to be correlated with each individuals' chronotype, as concluded Campos and De Martino (2004), cited by Silva, Prata and Ferreira (2014).

2.5.7 Emotional coping

On the Ohio study, mentioned at 2.5.1, researchers divide coping strategies into "problem-focused" and "emotion-focused" (Pisarski, Bohle and Callan, 1998). On their analysis, they state that within emotion-focused strategy, there are two factors: "disengagement coping strategies", which includes trying not to think about problems and wishing them to stay away by self-criticism and social withdrawal and "emotionally expressive" coping, which consists of letting emotions out or talking to someone about one's feelings. Finally, the "problem focused" coping is one where professionals try to solve a problem actively, reorganizing the way a situation is viewed (Pisarski, Bohle and Callan, 1998). This is a different and vague perspective on strategies for coping with shift work as it focuses on the existence of conflicts and the way each person handles it for keeping a good performance at work. In a broader way, most literature organizes the coping strategies by different domains that affect professional's ability to cope with shift work.

2.5.8 Gaps and Future Directions

There is a variety of research studies on the negative impacts of shift work and possible ways of minimizing its effects. However, there is not much knowledge on shift workers' day-by-day. Moreover, recommendations to lessen the effects of shift work are usually directed to the organizations to change something, either in a physical and environmental way, or through management practices, for instance, regarding the working schedules (Costa, 2010; Richter *et al.*, 2010; Prata, Isabel and Silva, 2013). Hence, there is not much about what shift workers can do by themselves to minimize the negative effects of their atypical working schedules and how technology can help in that sense.

2.6 Studying the Customer Experience

Customer experience is a set of internal and subjective responses customers have to any direct or indirect contact with a company, driven by perceptions over the provided service (Meyer and Schwager, 2007, Verhoef et. Al, 2009). According to Meyer and Schwager (2007), for a brand to be successful it should shape customer experiences, by implanting the main value proposition in each component of its offerings. "The increasing focus on customer experience arises because customers now interact with firms through myriad touch points in multiple channels and media, resulting in more complex customer journeys." (Lemon and Verhoef, 2016, p. 69). Data about customer experience is collected at different "touch points" (Meyer, and Schwager, 2007), which consist of each point of interaction between a customer and an organization, "across multiple channels and various points in time" (Zomerdijk and Voss, 2009). Experiences through each touchpoint inform customers' perceptions in regards to the whole service (Clatworthy, 2011). Those perceptions can be translated into tangible visualizations, through customer journey maps, which provide a high-level overview of the customer journey throughout a service (Segelström and Holmlid, 2011, Stickdorn and Schwarzenberger, 2016).

Although existing studies propose conceptual models with determinants[3] of customer experience and systematize experiences factors[4] (Carreira et. al, 2014, Verhoef et. al, 2009), most of them focus on the value co-creation between customers and product or service providers (**Figure 3**) (Carreira, et. al, 2014, Verhoef, et. al, 2009, Teixeira, 2015) or between patients and healthcare institutions (**Figure 2**) (Osei-Frimpong and Owusu-Frimpong, 2015). In this

3 Determinants may consist of experience factors, such as the atmosphere where the service is provided or the price of it. While some of the existing determinants may be controlled by the service provider, others cannot (Verhoef et. al, 2009)

4 Experience factors are the customer perceptions of all attributes of a product or service that contribute to the customer experience (Patrício et. al, 2004)

research study, however, the dyad in matter is between an employee and its organization. Ultimately, we may even be talking about a self-created experience, mediated by technology.

Figure 2 - *Patient experience map* (Bate and Robert, 2007, p. 139)

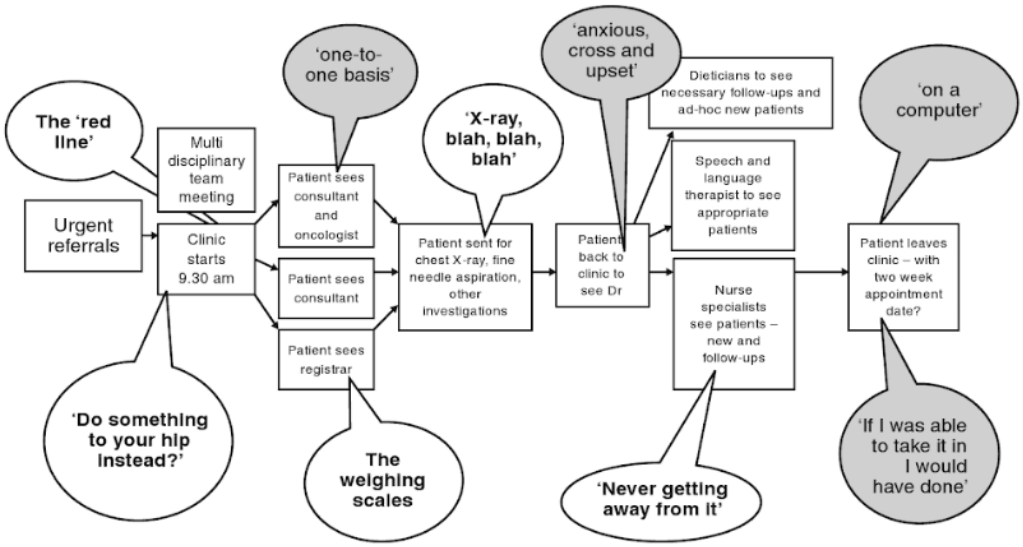

Figure 3 - *Example of a Customer Journey of a Product Provider* (Segelström and Holmlid, 2011, p.7)

2.6.1 Customer Journey Map

Teixeira *et al.* define customer journey as a sequence of "interactions with a service provider across different touchpoints" (2012, p.364). These include not only moments during a product or service provision, but also what happens before and after that (Yan, 2018), enabling service designers to understand and address customer needs and pain points (Gibbons, 2017). Using customer journey map, service researchers can craft appropriate resources for improving the overall service provided (Evenson, 2005). According to Mager (2008), there are many successful stories, among which McDonald's has beneficiated from a customer experience innovation centre. In fact, Service Design researchers have acknowledged the increasing importance of customer experience for service innovation (Patrício and Fisk, 2017).

2.7 From Customer Experience to Service Design (SD)

Service design is a multidisciplinary field (Ostrom et. al, 2010; Kimbell, 2011; Meroni and Sangiorgi, 2011; Patrício and Teixeira, 2016; Patrício and Fisk, 2017), defined as "a human-centred, creative and iterative process where visualization plays a key role" (Patrício and Teixeira, 2016). In this sense, and bearing in mind the human focus, Service Design encompasses understanding customers and their contexts by exploring their needs, dreams and behaviours (Patrício and Teixeira, 2016). This way service designers do not just answer *what* they are designing, but also *how* they are doing it (Patrício and Teixeira, 2016), which can leverage service design to promote its innovation (Patrício and Teixeira, 2016).

2.7.1 Multilevel Service Design

As an interdisciplinary field (Ostrom et. al, 2010; Kimbell, 2011; Meroni and Sangiorgi, 2011; Patrício and Teixeira, 2016; Patrício and Fisk, 2017), Service Design has many different approaches, and therefore, many available tools to assist its process stages (Patrício and Fisk, 2017). This diversity hampers an unified and integrated approach (Patrício *et al.*, 2011; Patrício and Fisk, 2017), which was the reason why it was defined a Multilevel Service Design method (Patrício and Fisk, 2017) A Multilevel Service Design (MSD) is an integrative method for designing complex service systems (Patrício *et al.*, 2011; Teixeira *et al.*, 2011; Patrício and Fisk, 2017). Its contributions come from service development, interaction design and service design fields (Teixeira *et al.*, 2011; Patrício and Fisk, 2017). "The MSD models help analysing and discussing existing solutions or revealing problems in the customer experience and potential areas for service innovation" (Patrício *et al.*, 2011, p. 184).

MSD proposes three levels of customer experience (Patrício *et al.*, 2011; Teixeira *et al.*, 2011):

(a) Value Constellation Experience: represents the interactions a customer needs to perform with one goal in mind, occurring between the customer and the service providers who offer what the customer needs to accomplish his/her goal;
(b) Service Experience: is informed by the service encounters and factors that enable or hamper the desired experience;
(c) and Service Encounter Experience provides details on each single interaction with the service.

These three levels are important for the first step of MSD: (1) study the three levels of customer experience (Patrício and Fisk, 2017). After understanding the customer experience, the step number two is to (2) design the service concept[5] through a Customer Value Constellation (CVC), which result from interactions between the customer and all service organizations required to perform a given customer activity (Teixeira *et al.*, 2011). Following is the need to (3) design the service system by means of a Service System Architecture (SSA) or a Service System Navigation (SSN), which provide, respectively, an overview on the multi-interfaces of a company's offerings and alternative paths customers may take across different service encounters (Patrício and Fisk, 2017). Finally, the MSD ends with (4) designing the service encounter, using a service experience blueprint (Patrício and Fisk, 2017), which "maps the actions of the different participants in the service encounter, both frontstage and backstage" (Patrício and Fisk, 2017, p. 201). As the authors of the Multilevel Service Design state, "creating new services requires being open to customers' dreams and latent needs that were not previously considered, being open to new service possibilities beyond the existing service boundaries, and being open to new contributions that are crucial for an interdisciplinary service design approach" (Patrício and Fisk, 2017, p. 203).

5 Service concept is what values customers are paying for, how the service looks and operates, how customers experience the service, and what are the service outcomes (Yu and Sangiorgi, 2014)

3. Methodology

This chapter describes the methodology followed in the present work. Firstly, the chosen qualitative approach will be described. Then, follows the research design, explaining the steps that enabled the results of this thesis to be achieved. Following, the procedures describe the sample design, data collection and data analysis. Ethical concerns are also explained.

3.1 Qualitative Research

The proposed objectives for this master thesis were to understand how shift workers used and appropriated a self-management system to assist them in resting more efficiently (Clockwork, 2018). As shift workers face specific challenges due to their atypical schedules, it was important to make a clear understanding over the context of these workers (Patrício and Teixeira, 2016; Gibbons, 2017; Patrício and Fisk, 2017), based on real events that could reveal implicit aspects of their daily life (Beyer and Holtzblatt, 1998).

Like mentioned before, shift work is associated with health problems regarding circadian rhythms. But there is little understanding on how people engage in self-care practice. To understand the context of shift workers, it was used a qualitative research design, which enabled a detailed, contextual and multi-layered interpretation of the context and of the interaction with the developed system (Mason, 2002).

To complement this qualitative approach, and because there was a lack of knowledge on shift workers' practices managing their health, it was necessary to choose a methodology that would enable capturing their experiences. Hence, within the qualitative methodology, it was decided to follow the tenets of Grounded Theory as it would provide a set of principles and practices to enable perceiving and reflecting upon the participants' views (Charmaz, 2006), complemented with a Service Design approach, for obtaining a holistic representation of the shift worker experience (Verhoef *et al.*, 2009; Teixeira *et al.*, 2011; Yu and Sangiorgi, 2014; Kumar, 2016).

3.2 Contextual interviews

Before designing the Clockwork system, Fraunhofer conducted 27 contextual interviews (Beyer and Holtzblatt, 1998; Stickdorn and Schneider, 2011) with shift workers from different areas, within their workplace, which enabled people to feel comfortable sharing their insights and also made it easier for them to reflect on their routines (Stickdorn and Schneider, 2011). After analysing these interviews, Fraunhofer researchers decided to build a technology-based service for shift workers working in healthcare. To construct the necessary knowledge about these

workers' daily life, 16[6] of those 27 existing interviews were read, analysed and coded (Charmaz, 2006). To analyse the interviews, it was used Scrivener software. Scrivener is a word processing program that provides an intuitive and easy-to-learn interface which enables to easily list, organize and reorganize information (Literature & Latte, 2005). Its flexibility enabled to insert comments and write memos next to the quotes (**Annex F: Print screen of one memo within Scrivener software**), helping to interpret the data as it was being categorized (Charmaz, 2006). By successively comparing data with data, data with emerging categories and establishing "relations between concepts and categories" (Charmaz, 2006, p.23), the practices and issues faced by shift workers were progressively identified according to their point of view. This analysis helped to better compare shift workers' needs (which emerge from the characteristics of their working arrangements) with the service provided through the technological solution that was designed.

3.3 Interviews during the pilot

Once an understanding over shift workers' context was achieved, it was necessary to conduct a pilot where shift workers would use the Clockwork system. José de Mello Saúde was the project's healthcare partner, so the recruitment of participants was their responsibility. Although participants should be the same interviewees from before the system's development, there were requirements for making part of this pilot. The requirements for selecting the potential volunteers were:

- being a shift worker (preferably also performing night shifts)
- age 45 years onwards
- should have an Android (version 5.0 or higher)[7]

Once volunteers (**Table 1**) were identified, it was scheduled a first meeting. In this first meeting, the pilot goal was explained, and the Clockwork system was introduced. After this, an informed consent (**Annex A: Informed Consent)** was presented for the volunteer to confirm what had been explained (Mason, 2002). Once the informed consent was signed, the Clockwork system was installed. Installing the system comprised three steps: (i) put a box at the participants' workplace, (ii) replace the ID badge case for the Smart Badge and (iii) install the application on the participants' mobile phone. When the volunteers' mobile phone was not compatible with the Clockwork application, they were given a mobile phone by Fraunhofer. Besides these

[6] Corresponding to the number of interviews from shift workers working in healthcare

[7] Only these versions would support the Clockwork application.

proceedings, a first small interview (**Annex C:** ***Interview outline when starting to use the Clockwork system***) was conducted. The goal of this first interview was to perceive the participants' expectations and goals (Stickdorn and Schneider, 2011; Patrício and Fisk, 2017) towards the introduced system.

Table 1 - *Data about the participants*

Participants ID	Profession	Age (years)	Gender	Experience (years)
P08	Orderly	49	Female	9
P09	Orderly	57	Female	2
P21	Nurse	49	Female	28
P24	Nurse	52	Male	16
P27	Orderly	51	Female	6

After this first introduction to the Clockwork system, intensive semi-structured interviews (Beyer and Holtzblatt, 1998; Stickdorn and Schneider, 2011) were conducted with the 5 participants, for 8 weeks, with 2 weeks of interval between them (**Table 2**).

Table 2 - *Sample design*

Data sources	Collected by	#Participants	#Interviews	What was performed in this research
Interviews **before** the system development	Fraunhofer researchers	16	16	- Interviews' analysis and codification for context understanding
Interviews **after** the system development	The student	5	18	- 5 Semi-structured interviews before contacting with the system (all in person) - 8 Semi-structured interviews during the pilot (6 in person, 3 by call) - 5 Semi-structured interviews after the pilot (3 in person, 2 by call) - Audio-recordings: 10 hours 20 minutes

System logs	The student	5	--	- Sleep records' analysis - Activity, light exposure, calendar and 'analytics' (usage time) analysis

These interviews enabled "an in-depth exploration" (Charmaz, 2006, p.25) of the shift workers experience with the Clockwork system, gaining their own view and interpretation about it. The interviews were recorded and transcribed verbatim (Mason, 2002; Stickdorn and Schneider, 2011), and analysed afterwards individually (Mason, 2002). Data analysis followed once again some tenets of Grounded Theory. The objective was to identify actions or beliefs, organizing units of information (codes) that could enable to discover themes or patterns (Charmaz, 2006). Considering the available time to perform this analysis, the unit of analysis was extended to whole paragraphs, trying to gather all the insights that participants had shared.

These codes were then iteratively compared and analysed, to establish relationships between them (axial coding) (Charmaz, 2006). This type of coding enabled to identify redundant codes that could be merged, or hierarchies that could be established (Charmaz, 2006). In each code, the quotes of the participants that expressed that idea were listed (**Image 3** - Print screen of one subcode of analysis in Scrivener).

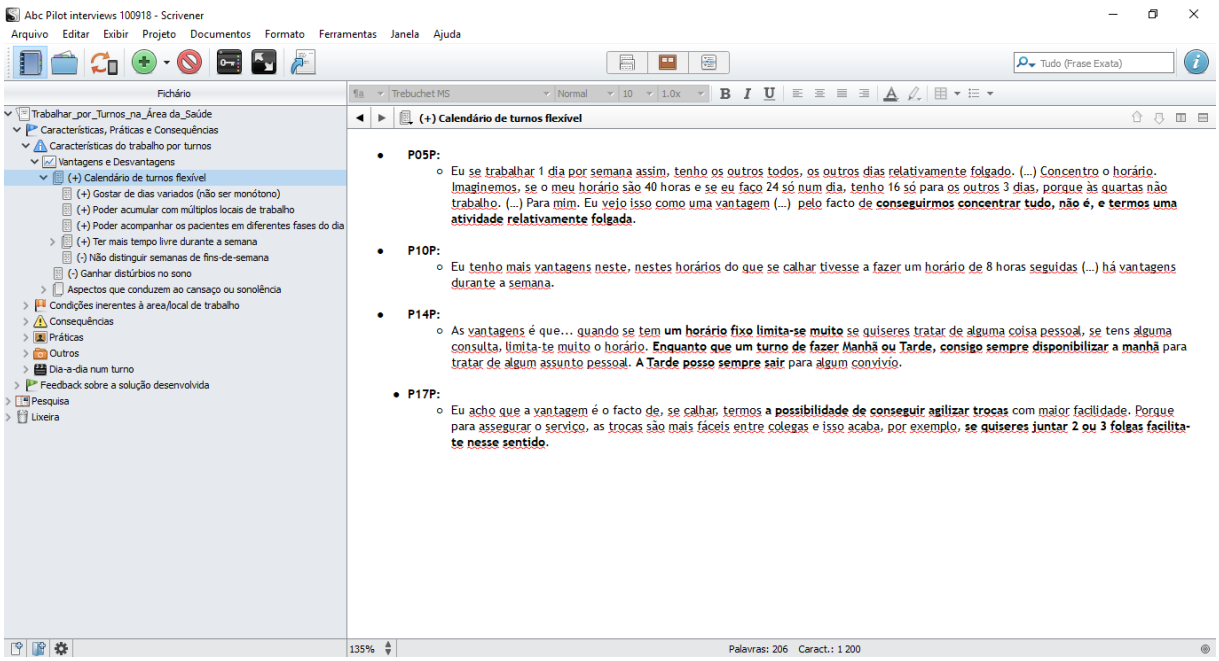

Image 3 - *Print screen of one subcode of analysis in Scrivener*

If there was a higher number of participants, the number of quotes per code could provide an insight on the relevance or application of the idea expressed, however, since there were only 5 participants, it is not possible to generalize. All general conclusions should be restrained, being only possible to discern whether if the system has potential or not.

System log analysis

During the pilot, system logs (**Image 4**) were also analysed, as a way of planning the qualitative interviews (Mason, 2002, p.67), as they provided some hints about the participants' interaction with the application besides the interviews. As such, that analysis enabled to verify some facts which could be clarified when talking to the participants.

Beyond this interaction, which enabled the identification of possible barriers and drivers to the system's usage, a major interest of this phase was to perceive if the Clockwork system produced any change compared to the initial data that was collected. This touches one principle of Grounded Theory: to evaluate the fit between initial research interests and emerging data (Charmaz, 2006, p.17).

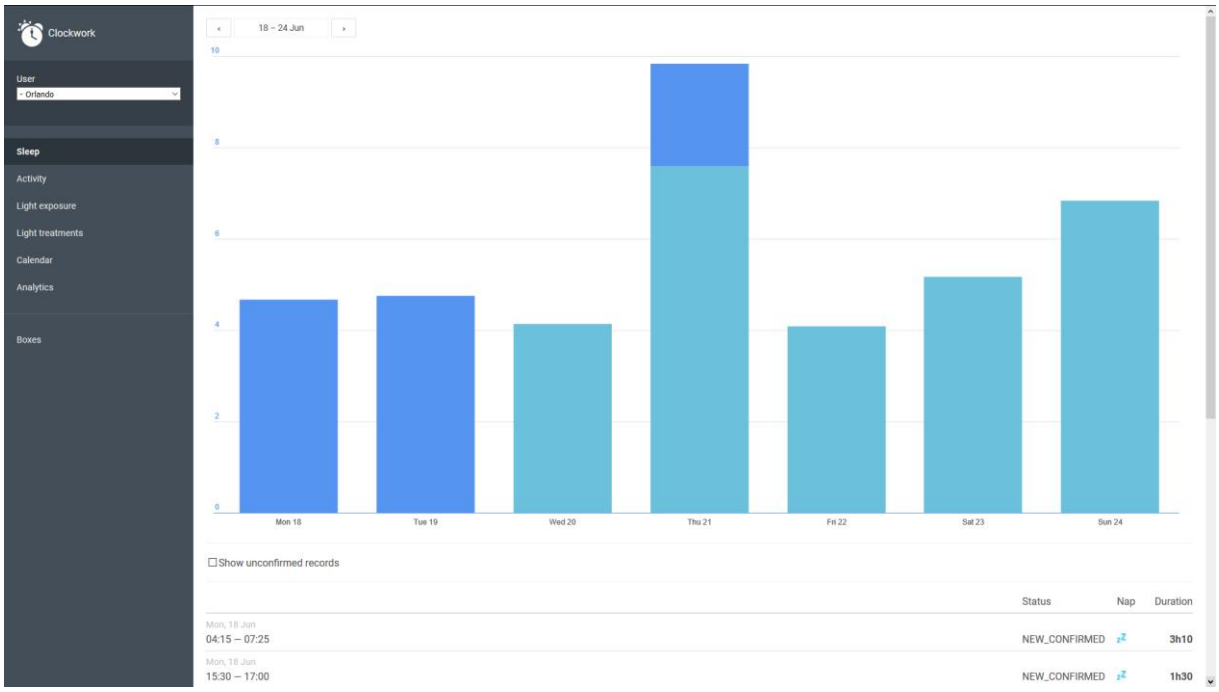

Image 4 - *Print screen of Clockwork backend dashboard (sleep tab)*

Ethical Concerns

The interviews were conducted with shift workers from CUF hospitals. To address the ethical concerns, the project applied an informed consent document to the Ethics Commission of CUF. This document identified the research objectives and established what was expected from the participants.

Participants' information remained confidential, being that each interview was identified with the respective participant attributed code. As the voluntariness of the participants was very important for a better cooperation between participants and researchers, this aspect was never taken for granted. In this sense, participants were remembered, whenever necessary, that they should feel free to give up on their contribution whenever they wanted, without having any injury. Finally, when asking about the participants' experience both as shift workers as in regards of their use of the Clockwork application, it was always considered the respect for the participants, having never judged their opinions.

4. Results

This chapter presents the most important results of data analysis, structured according to the two phases of the study. The first findings result from the codification and analysis of the first set of interviews, where methods of Grounded Theory were applied, and a Customer Journey Map was modelled. The objective was to find out what challenges shift workers revealed to face in healthcare and the practices they performed to cope with them. After understanding the context where the evaluated system was introduced, it follows the second part of the results, where the main outcomes from this research study will be introduced. Results will be accompanied by some quotes from the participants, providing a sneak peek on their feedback, which facilitates the reflection on their views. (Charmaz, 2006) Furthermore, it will be discussed whether the technology-enabled service (the Clockwork system) promoted any change in the shift workers experience.

4.1 Contextual interviews

As previously mentioned, the first results were obtained through the analysis of interviews that were previously conducted (**Annex B: Contextual interview**) by Fraunhofer when designing the Clockwork system. While Fraunhofer researchers were concerned with designing the Clockwork system, the questions made during the interviews discussed different issues about the interviewees' experience as shift workers, uncovering both issues and challenges faced by these workers as well as practices they used to cope with those characteristics. My analysis focused on finding the characteristics that would best describe the particularities of the context in which the technology-enabled service under evaluation was going to be introduced. Through an analysis grounded in the data, it was possible to construct a set of interrelated characteristics (**Image 5**) that impact shift workers routines – resting and personal ones –, as well as evidences of how they manage to balance them.

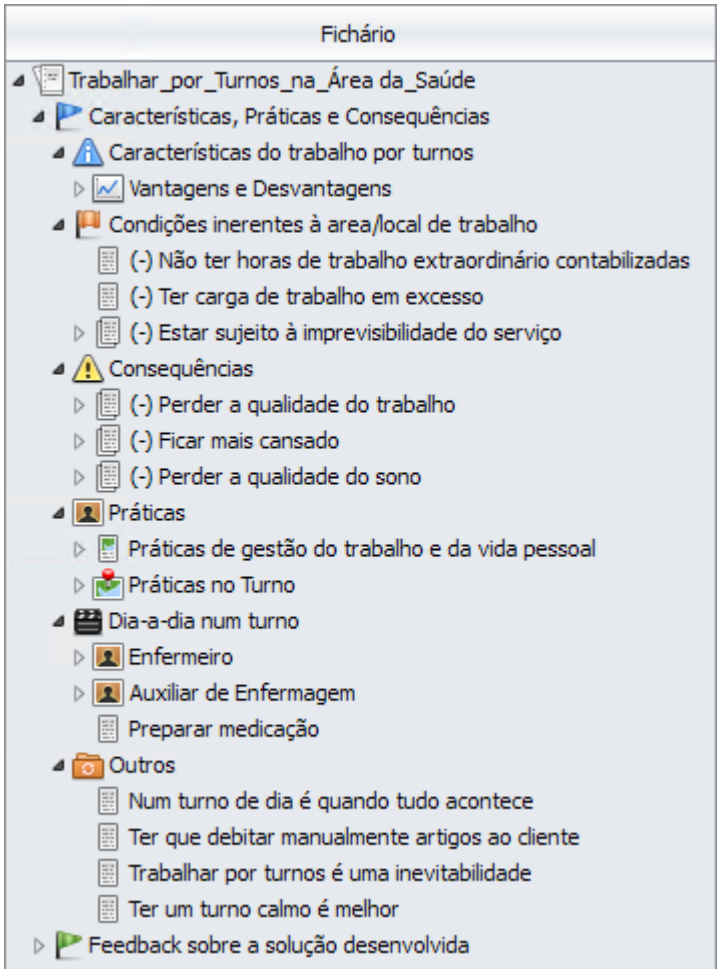

Image 5 - *Scrivener overview of the codes' structure of contextual interviews*

4.1.1 Characteristics of Shift Work

When someone works in shifts in healthcare, they usually have a changing schedule. People can work on weekdays, weekends, or even on a holiday, as the service is open 24 hours. Besides the indiscrimination of the days of the week, schedules vary as workers rotate between working shifts. The interviewed participants mentioned seven different shift types (**Table 3**): *small morning*, *morning*, *small afternoon*, *afternoon*, *small night*, *night* and the *24-hour shift*. Each participant had two to four shifts from this subset in their monthly schedule. Therefore, shifts are not performed by all the professionals. For instance, physicians usually do mornings, when they are at the hospital admission providing consultations, and once in a week, they perform 24 hours shift[8] to assure the emergency service. Although most physicians do 12-hour shifts, there is an exception; anaesthetists and surgeons have specific shifts of 6 hours each. However, they

[8] The weekday is not always the same. It has an 8-week cycle of rotation regarding the day in which they do that shift.

still work for 12 hours most times since it is frequent to perform two shifts in a row. Then, in what comes to nurses, they have many different working schedules, being able to perform any of the presented in the table. Finally, orderlies do mostly four of the existing working schedules: small mornings, mornings, afternoons and nights, being the smaller shift of 6 hours and the bigger one of 12 hours.

Table 3 - *Types of shift schedules from the interviewed participants*

Shift name	Hours	Healthcare profession	Duration
'Small' morning	08:00 – 16:00 09:00 – 13:00 08:00 – 14:00	Nurse Orderly/Anaesthetist/ Surgeons	8 / 4 hours 6 hours
Morning/Day	08:00 – 08:00	Physician/Nurse/Orderly	12 hours
"Small" afternoon	15:30 – 19:30	Nurse	4 hours
Afternoon	14:00 – 20:00 15:00 – 22:00	Orderly Nurse	6 hours 7 hours
'Small' night	22:30 – 8:30	Nurse/Orderly	8 hours
Night	24:00 – 08:00 20:00 – 08:00	Physician/Nurse/Orderly	8 / 12 hours
24-hour shift	8:00 – 08:00 09:00 – 09:00	Physician	24 hours

Performing different types of shift might be challenging because shift workers can never establish a routine. The times in which they work vary and the number of hours they work is also different, which motivates shift workers to constantly adapt to schedule changes. This lack of routine and constant adaptation brings advantages and disadvantages to shift workers' professional and personal life. Although most disadvantages were consensual among participants, some shift workers said that they would not be willing to change their job.

4.1.1.1 Advantages and Disadvantages of Shift Work

One of the advantages identified by shift workers was the ***flexibility of shift schedules***. This flexibility allows shift workers to ***have more time in a row*** to be at home during the week, enabling them to rest. Shift workers are happy with the possibility of being with friends, family

members, or even having leisure moments by themselves. Parents of young children are sometimes able to stay with them at home on weekdays during the day (Williams, 2008). People with more typical work schedules do not have this possibility and usually must leave their kids to the nursery, to a nanny or to some relative, like grandparents, for example. This is one of the advantages for which shift workers would not renounce the type of work they do.

Above all, having more time during the week can enable shift workers to rest. Resting is essential as workers often work more than 8 hours during a day. The overload of working hours requires workers to rest more time than usual. However, if some participants mentioned that these times at home during the week enabled them to rest and be in peace, the truth is that other participants used the time in other activities. One of the best examples was ***being able to go to public institutions during weekdays***, without missing work. As P02 explains, public departments have specific office hours during the week, and they usually are not opened at weekends, which makes these services harder for people with regular work schedules to visit.

> P02: *[Working in shifts] enables me to take a day off in a weekday (...) to solve problems at public departments, financial departments, which are only opened in certain schedules during the week (...) without having to miss work.* (Female, physician, 29 years old)

The idea behind what P02 was saying resides in the fact that performing a 12-hour shift and working at the weekend makes it possible to take a day off in a week day. For someone who has a regular working schedule during the week from 9 am to 7 pm, it is only possible to have a day off during the week by missing their job, spending holiday days. While some appreciated a day off during the week, many complained about spending the weekends working. Since most people are free at weekends, shift workers reported feeling ***desynchronized from their family and friends' routines***, which compromised their personal and social life, as P11 exemplifies.

> P11: *Sometimes she [her 14 years old daughter] says: "Mom, you always work on the weekends, we cannot go anywhere".* (Female, orderly, 47 years old)

The testimony of this participant is a good example of how workers miss out on some activities. In addition, it also shows the impact shift work can have on one's personal life, bringing not only consequences for themselves, but also to those who live with them. Not being able to spend

time with the loved ones is something that weighs on shift workers day-by-day. This participant's daughter even argued that she spent more time with her father than with her mother. The only thing the mother could say was to agree. Like she shared with us, "If I consider, I did not see her yesterday, today I won't see her, tomorrow she goes out, I [will] only see her at the afternoon. Practically, I am two days without seeing her". Examples like these might lead to further demotivation at work and an increased sense of dissatisfaction with one's personal life[9] (Lipovcan, Larsen and Zganec, 2004; Li *et al.*, 2014).

Many shift workers considered an advantage the ability to accumulate two or more jobs, since that enabled them to accumulate two or more sources of income. Receiving more than one salary helps securing a stable life, especially when workers have children dependent on them. There was even a participant who worked in two different places who mentioned that she would keep the two jobs at least until her kids finished their studies. Once they graduated, she would consider quitting from one of the jobs, she said, as it would be then enough to live with some comfort.

Additionally, from the professionals' perspective, performing shift work can even enable a ***better follow-up of patients' routines***. Since workers accompany patients at different moments of the day, they can better understand their health status and specific characteristics, becoming more effective in their health interventions.

There are disadvantages, however, counterbalancing the shift work scenario, which relate to aspects that provoke increased fatigue and sleepiness at the workplace. Having to cover 24 hours of service, originates longer shifts. Working more hours per day than common working arrangements causes ***increased fatigue***:

> P08: *Of course, when we do night-night [shifts], we end up feeling an increased tiredness that we haven't felt in the first [night], obviously.* (Female, orderly, 49 years old)

As explained in the excerpt, after a first night shift, the shift worker did not notice increased fatigue. However, the second night shift triggered an increased tiredness. This happens because on one side the worker does not have time to recover from one shift to another one and, on the other side, because she worked for a high number of hours. Performing two night shifts in a

[9] Frustration is such that a participant even shared that she gets grumpy when someone wishes her a good weekend. While for people with regular schedules, weekends are enjoyable and restful days, for her they often mean work.

row totals 24 hours of work in a period of 36 hours, while a common (non-shift) worker works a total of 16 hours, with 8 hours of free time (**Figure 5**).

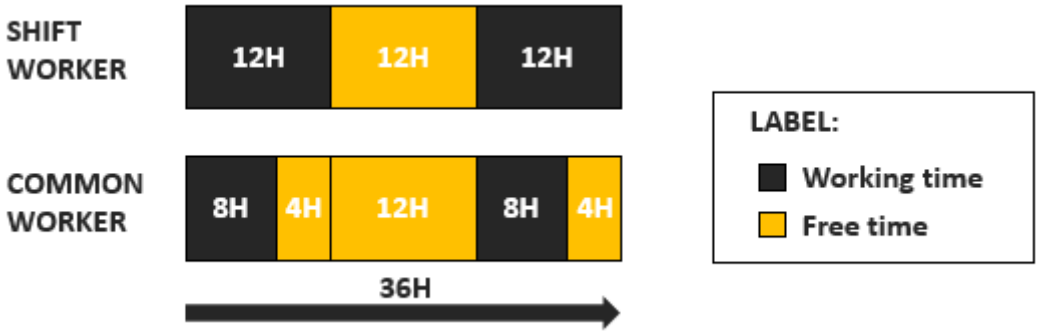

Figure 4 - *Comparison between a shift worker performing two-night shifts and a common worker doing a regular working schedule*

Even if shift workers can slowdown in the middle of a night shift, most times they need to do records on a computer. Day shifts also comprise this task, but the difference is that while in a night shift, the transition to the computer is not so easy due to the contrast between the darkness of the workplace and the brightness of the computer screen. After a long shift ***walking from one side to another*** or performing tasks ***under stress***, the transition to the information record is not that trivial. In fact, participants refer to this task as something boring, that takes too long, making them feel sleepy and, thus, struggling to keep alert until their shift ends. Hence, the fact that shift workers feel sleepy worsens other factors, like the fact that they cannot do much noise, once patients will be sleeping. The fact that shift workers must remain on a dark and calm environment promotes their sleepiness. ***Being alone in the night shift*** makes it even harder to stay awake. Shift workers report that it becomes more difficult to maintain alertness in off-peak periods when one is alone. However, for healthcare professionals, disadvantages are not limited to these ones. Some aspects relate to the area to which these shift workers work, adding additional inconveniences to shift workers' experience.

4.1.1.2 Problems arising from health work

As above mentioned, some issues faced by shift workers had more to do with the fact that they worked in healthcare than with their shift work arrangements. One of the problems was ***having to work beyond their working schedule***. This materializes in four ways: (i) consistently perform work that is not counted as part of the working hours, (ii) work more hours per week than what

is legally expected, (iii) do more emergencies or nights per week than what is recommended, and (iv) extending their shift due to unpredictable needs or unfinished interventions on patients, as will be explained below.

Healthcare professionals must hand over some information to the colleagues that will replace them. This moment is called the *hand over* and it consists of transmitting information about the interventions one has done along the shift, who are the patients, why they are there and if they are dependent or semi-dependent. Although this information is crucial for the colleagues that have just arrived, the working schedule does not contemplate the time spent during the shift change. However, it is still part of their job and is something that, depending on the function, can take time. Usually, nurses take more time in this task than orderlies, because they also must talk about the medicines that were administered. The fact that they spend about 15 to 30 minutes beyond their working schedules every single working shift, is something that steals them time. Besides this issue, P17 describes the second problem:

> P17: *First, we should all comply with a 160-hour work schedule, which is not met from the outset. (...) For lack of personnel. [And this] causes a surplus and a workload for a person to do 50 hours of work per week. [These] are many hours. (...) We're talking about you having one day off per week, is it not? One day off per week for a normal person to recover from a week of six working days... It's too heavy! It's too heavy! (...) In addition, there is not so much respect on the part of the Head and the Administration regarding which are our rest moments. After a night [shift], it should always be mandatory [to have a] rest [day] followed by a day off, and that is not fulfilled due to the lack of personnel.* (Female, nurse, 30 years old)

Like we can read, whether because of the way the work is organized – the example about the shift change – or due to lack of personnel, people are ***working beyond the time that is legal*** per week, sometimes not even being paid for that. These extraordinary working hours contribute to the shift workers physical and psychological wear, which makes working in shifts extremely demanding. Furthermore, sometimes the number of shifts per month is not balanced (topic number iii), and workers see themselves with a ***higher workload than what they should have***.

> P02: *I remember that there was here a month where I had 8 emergencies, the 4 usual and 4 extras. Of these 8 emergencies, 2 were 'day' [shifts]. Therefore, there were 6 emergencies [at] night, which is not expectable or*

> *legal. But [that is] what we are obliged to do many times… [is to] try to cover all the holes of the emergency.* (Female, physician, 29 years old)

This case reports situations where people have consecutive shift types, which are supposed to be distanced. This is the case of nights or shifts of 24 hours at the emergency department.

Beyond these issues, participants often mentioned that they were also ***subject to the service unpredictability*** (topic iv). Emergencies are not programmable work, patients' conditions might be better tamed or not, and it is difficult to predict how many patients will request the attention from the workers. P05 mentioned that the emergency had a great impact on him.

> P05: *The problem with the emergency is the indefiniteness that it wears. The emergency, we never know how it will be.* (Male, physician, 31 years old)

Since it is never possible to know how things will progress in the emergency, it is not possible to plan work or manage effort optimally. Even though workers might plan their work and organize conditions, they will base their planning on conditions that might not materialize. The constant planning and re-planning leads workers to face further fatigue.

Another issue that promotes the unpredictability of work effort is related with having to support patients beyond regular work hours. Given the work of healthcare professionals influences the health and safety of human beings, work cannot be left halfway, as P07 explains.

> P07: *Sometimes the surgeries get complicated and we cannot come out at midnight and we have to prolong [the working time]*.
>
> (Female, nurse, 54 years old)

P07 gives the examples of when she has delayed surgeries. The characteristics of care took longer, and because of that she might have to prolong her shift. Meals, rest periods, or other administrative tasks will have to stay behind, because attending the patient is the priority. These conditions are negative aspects of shift work in healthcare, that affect shift worker's experience, making it more difficult to manage their available time to rest and keep their personal and social life. Some of these insights are simply conditions that are inherent to the healthcare sector itself, not being applicable to other areas, such as the security sector, where workers face more

monotony (Toit, 2015). However, these insights are important to keep in mind, as they play a role on the aspects that impact shift workers experience at the context in matter.

4.1.1.3 CONSEQUENCES OF SHIFT WORK

Consequences of shift work are closely related to its disadvantages. The main ones encompass ***losing work and sleep quality*** and ***having increased tiredness***.

Losing work quality is mostly related to the problems arising from healthcare sector. For instance, when workers reported neglecting some good practices at work, they essentially referred to activities that they neglected due to specific work characteristics. As mentioned previously, some areas of work at a hospital are prone to an increased stress, where healthcare professionals put all of their effort and attention for answering to all the demands that arise. In this context, the service is so demanding sometimes, and overall people are so stressed, that shift workers neglect some good practices to better cope with all circumstances.

> P02: *And there are situations where it is not indicated to provide an antibiotic at all… And sometimes I, for me and for my colleagues, it is easier at that hour [of the night] to give the antibiotic and the person goes away, than having to explain to parents. (...) Especially when parents come up with that idea: "My son needs an antibiotic."... And a person no longer has... This is a bad practice.* (Female, physician, 29 years old)

In this example, P02 reveals that she prescribes antibiotics to children when they would not need, to avoid long explanations to parents who believe their children need to take an antibiotic. The participant explained that during the day the proceeding is different, but when in a night shift, paediatricians no longer have patience to contradict parents and explain them why their children do not need an antibiotic.

Other examples of losing work quality range from putting a patch on a patient with less perfection to leaving information records undone. On the first case, healthcare professionals often have to repeat some tasks when a colleague arrives to join them, so that they are able to perform it with more perfection. Regarding the information records, the way that information systems are organized are not practical for a quick record. Participants complain about losing too much time doing records, because they have to record everything they have done to patients and each material that they have used, as well as the progress of the patient. This becomes particularly difficult when they have big lists from where to choose options or when they have

to wait for the system to start. A participant even suggested that researchers should see how many records they do. In consequence, shift workers either spend more time with patients, abbreviating the information they introduce in the system, or they have less time to spend with patients in order to make complete records of all the work they have performed.

On one hand, the lack of information records may lead to receive lower grades in quality audits, not safeguarding shift workers performance since their interventions are not fully stated. On the other hand, the lack of time spent with each patient may lead to a decreased level of service quality. Despite both situations being undesirable, it is not shift workers' job to eliminate these constraints. However, once they face these issues every time they go to work, they need to manage them somehow. This will certainly contribute to their mental fatigue. Unfortunately, everything seems to increase fatigue for shift workers working in healthcare.

Also related to the conditions to which shift workers are subject in healthcare, there is the loss of capabilities over time, like P11 confesses.

> P11: *When I came to the interview I already knew I would do rotating shifts, I would not get a fixed schedule. But at that time, I was very young, right. I used to go and come back very well. Now, the age is moving forward… it's logic (...) maybe 3 years ago I had more strength or was able to do much better than now.*
>
> (Female, medical assistant, 47 years old)

The fact that shift workers have so many aspects contributing to their tiredness and the fact that their atypical working schedules affect their personal routines impacts their sleep quality. A compromised sleep quality takes many forms. It can be represented by struggling to fall asleep, waking up all the time, dreaming about their job or being hard to wake up. If some shift workers still have the ability to manage themselves, others reported having their family members helping to promote a better sleep quality by going away from home to leave them in peace while they sleep or even waking them up, so they do not miss their commitments.

The fact that shift workers constantly lack a good sleep quality impacts not only their physical and mental capabilities but also their mood. A lot of shift workers reported to get bad humour and become less tolerant easier than what is usual, especially when they are sleep deprived.

> P14: *When I come out from a night [shift] I feel less tolerant, but that is normal, because anyone who rests poorly gets mood changes. But usually, it's not always when I come from a night [shift]. As I said, it is my accumulated fatigue. It's on the next day that I get those [mood] changes. (...) On the next day a person is grumpier.* (Female, nurse, 30 years old)

P14 explains that she feels less tolerant when she comes from a night shift. However, sleep deprivation does not always manifest immediately after a night shift. The accumulated fatigue extends to the next day.

4.1.2. Practices of Shift Workers

With so many challenges to face, shift workers end up using some strategies to cope with shift work characteristics and consequences. Those strategies encompass practices at home, which are related to the management of their personal and social life, and practices at their job, while in a shift, to manage the tasks they need to perform, their alertness and their feeding and resting needs.

4.1.2.1 MANAGING SLEEP TO FIT PERSONAL AND SOCIAL LIFE

Practices at home are mainly about two domains: one is to ***manage sleep*** and the other one is to ***coordinate and adapt schedules*** to family and friends. These two domains show that shift workers care about both their health and well-being and their personal and social life. To balance these two important things, shift workers have some strategies, ranging from doing relaxing activities that help falling asleep, to ***choosing the best moment of the day to rest***.

While some workers sleep more than usual before a night shift, like P07, others prefer to compensate the lack of sleep only after the work, like P02.

> P07: *I try to sleep during the day, even if it's just a nap, and to rest by the end of the dinner.* (Female, nurse, 54 years old)

> P02: *In the following day [to a night shift] I go home, take a bath, [I have] breakfast and I sleep. I can sleep until 2pm, I can sleep until 3pm. If the night has been very, very bad, [if] I didn't stop all night, sometimes I sleep until 6 pm.* (Female, physician, 29 years old)

To easily fall asleep, some shift workers have specific activities that promote ***becoming more relaxed and calmer***. For example, going to the gymnasium, gardening, reading or watching a movie.

4.1.2.2. MANAGING SLEEPINESS IN THE WORKING SHIFT

While in a night shift, however, resting strategies are more difficult to put in practice. Like previously mentioned, shift workers in healthcare are subject to the service unpredictability. Hence, depending on how much work appears to do, workers may have the opportunity or not to take a nap or simply rest. Regardless of that possibility, there are people who prefer not to sleep at all to provide an appropriate service. From their point of view, ***not sleeping in their workplace*** is a matter of responsibility, as there are patients to take care of, who may require their attention at any time. These professionals do not feel comfortable about having the bells ringing (because of patients calling for help), while they are sleeping. Rather, they prefer to just sit on a big chair resting, although still alert, or even walking from side to side, checking if everyone is okay or needs something. As a way of ***keeping oneself alert***, shift workers have feeding and entertaining strategies (**Table 4**), like eating (P02) and drinking coffee (P17) or reading (P09) and playing video games (P11) or even watching movies (P08).

For those who are willing to rest, they have to try to arrange time for that, but since they cannot control the volume of work, the only thing they can do is to manage their tasks in a way that it leaves room for resting. P08 tells us how she does all her tasks in a row.

> P08: *As long as I do not have the work, let's say, ready I cannot sit and stretch my legs a bit. I must tell you that sometimes there are night shifts that there are 4:30 in the morning when I can say like this "okay, I have everything ready".* (Female, orderly, 49 years old)

This worker prefers to leave everything done firstly, instead of splitting tasks to keep herself awake. Hence, in this case, having time to rest is important for her. However, she was one of the examples who did not want to fall asleep, because she would not feel professional missing a bell ringing. Therefore, this was one of the examples where workers had to distract themselves

with entertaining artefacts, so that they would keep their brains active and, thus, maintain alertness.

Table 4 - *Quotes from one sub code of "Not sleeping to provide a good service"*

Keeping oneself alert	**Food strategies**		**Eating:** P02: I eat a lot more. (...) [When] I am a little sleepy what I usually do is: I eat. I eat cookies, I eat things that give me energy: chocolates, dried fruits. Uh... and that makes me stay awake.
			Drinking and taking coffee: P17: I drink coffee! And I drink water. I drink about 1,5L of water during the night period and about 3 to 4 coffees. Expressos.
	Entertainment strategies		**Reading:** P09: During the night, when someone does not have what to do... it's never much [time], but one can rest, read a book.
			Playing: P11: Me? I go playing in the mobile phone. I sit down a little and play. (...) Because otherwise I fall asleep.
			Watching a movie: P08: Uhhh, doing something... (...) at least watching a movie in the tablet (...) it's the way I have to keep myself alert and so.
	Work planning	Splitting tasks along the working shift	P23: Sometimes I put myself doing stuff there at the computer

4.2 Shift workers' experience with the Clockwork system

4.2.1 Shift workers' goals

Initially, the participants' stronger motivation was ***to know if they were working too much***. Besides the willingness to contribute to the research study and to benefit someone in the future, this was the only aspect they mentioned as their own motivation to participate.

When explained about the system's objective and functioning, shift workers showed higher expectations towards their resting needs and lightning conditions. In terms of sleep, they said

that they wanted ***to know what their own limit was*** and, therefore, understand if they were appropriately managing their health or not. Moreover, ***receiving counselling about sleep***, like, for instance, telling them when to stop working, was something they expected the system to enable. In what respects lightning conditions, participants were worried ***to know if the lights in their workplace were appropriate*** for their health. Despite being curious about these aspects, shift workers did ***not expect to gain any benefits from the use of the application***, or at least they were not confident that it would enable them to change anything, even if it showed data about inappropriate habits for their health, because they argue that it is not possible to change neither their work schedules or environmental characteristics of the workplace nor their personal habits.

4.2.2. Resistance towards a change

In regards to the participants' disbelief towards the system, shift workers pointed out some reasons to explain why they were not confident about getting any benefit from the use of the application. Recalling the provided information, the Clockwork application presents records about the participants' sleep, activity and light exposure.

In terms of sleep and activity, it was very common to hear from the participants that they already had the notion that they should rest more. One participant (P09) even said that she had her own routine and that she considered herself to manage her rest very well, contrary to what she thought about other colleagues. In general, all the participants were a bit reluctant towards expecting any change in their habits. In their words, their lifestyle could not be changed, so they said to rest depending on their need. As for their working shifts, when doing a night or an emergency shift, they said that they could only rest if the volume of work allowed them to do so, due to service unpredictability.

In what comes to the light exposure, participants were conscious that in their specific workplace they did not have much natural light and that it boosted their tiredness. However, they felt that it was not their responsibility, explaining that it would be something that only the organization could change.

4.2.3. Context of use

The context of use is an important aspect to refer. Testing a solution in the participant's real environment enables getting a higher ecological validity (Interaction Design Foundation, no date a). The ecological validity consists of the extent to which the conditions where the study is undergoing are close to the normal day to day situation, potentiating the applicability of its

results (Interaction Design Foundation, no date b). In this sense, it is important to define the context where people used the Clockwork system.

In this case, the solution was tested in real-life scenarios, what is often referred as “in the wild” (Rogers and Yvonne, 2011).

Shift workers used the system where their usual routines take place, this is, both at home and at their workplace. According to the participants, the place where they had more opportunity to explore the app was at home. When interacting with the app at home, the purpose was generally to see their total slept hours and to confirm or add new sleep records (in case the system was failing on that aspect). The most referred time for verifying the app was between the morning and the lunch time. Besides using the app, some participants charged their badge at home. Only one participant (P24) talked about charging the badge at his workplace.

When at work, there was not a typical phase of the day to consult the application, contrary to what happened at home. What determined the moment of use was the working shift they were doing - if it was a morning shift, they would consult in the morning, if it was a night shift, they would do it at night - when an opportunity to rest arose. Although some of the participants checked their sleep records and saved their nap times during the shift, the information they most looked for in this situation was their physical activity level. This was an aspect that was only being recorded while they were working. So workers felt curiosity regarding the type of activity they were having. This way, they wanted to know if the application was showing that they were having little or vigorous activity.

4.2.4. Performed activities when using the system

When using the Clockwork system, there were some activities shift workers had to perform in order to achieve their goals. Since shift workers wanted to know their resting needs, they should ***check their records*** about the number of slept hours and their level of activity during the work. It is more likely that someone with few hours of sleep will feel more fatigued or tired than someone who have slept more hours, however, what works best for one person, does not necessarily work well for another one. However, each person individually can evaluate his/her own resting needs by comparing the number of slept hours, day-by-day.

Also, the level of activity on each shift, might provide an idea of shift workers’ effort and, therefore, enable to decide how much they need to rest.

This being said, shift workers performed some activities that enabled them to keep track of their sleep and activity records. To start, they had to ***enter the type of shifts*** they performed, defining the range of time for each shift and labelling it with a name, two initials, and a colour. After

this, they would ***set up their shift calendar***, by selecting a day and, on each one, choosing the working shifts they would be doing. The result was something like the image below.

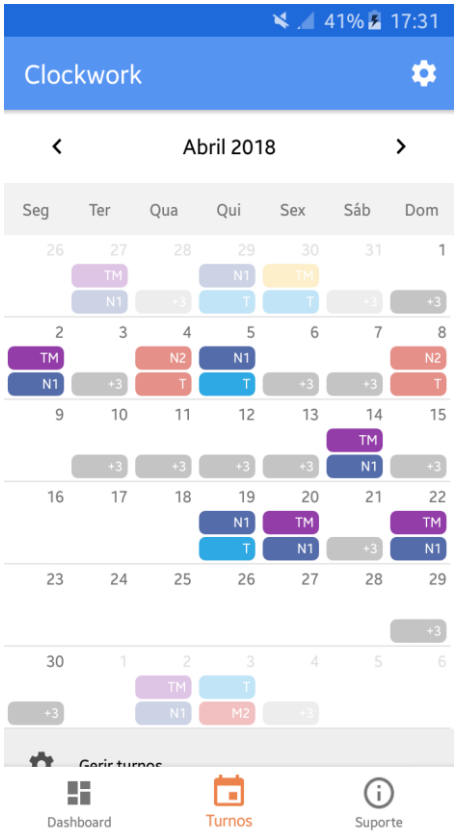

Image 6 - *Screenshot of the Clockwork application calendar*

Only one participant (P09) had difficulty doing this, because, like she mentioned, she is not very comfortable with technology. So, in this case, this worker had a colleague helping her. Her colleague explained again how the application functioned and inserted the working shifts for her. Having settled up the calendar, the Clockwork system was able to record data about the activity during a shift. Depending on the speed and type of activity, the system would distribute the percentage of each activity level (*inactive*, *light*, *moderate* and *vigorous)* into a bar (**Image 7**). Yet, to keep track of shift workers' activity, they had to carry a smart badge with them. Hence, in the beginning of a working shift, they ***placed the smart badge in their neck or chest***, like they used to do with their identification cards. When finishing the shift, some would ***save their smart badge in a locker*** while others would ***take it home*** in their purses, where it remained until the next shift. Generally, shift workers would check their activity while working, to ***check what level of activity they were having***. Although they reported not changing anything in regards to this aspect, they still kept interest in this information. Participants were curious

regarding their activity level, but in their opinion, the provided information was not enough for their reflection and decision making.

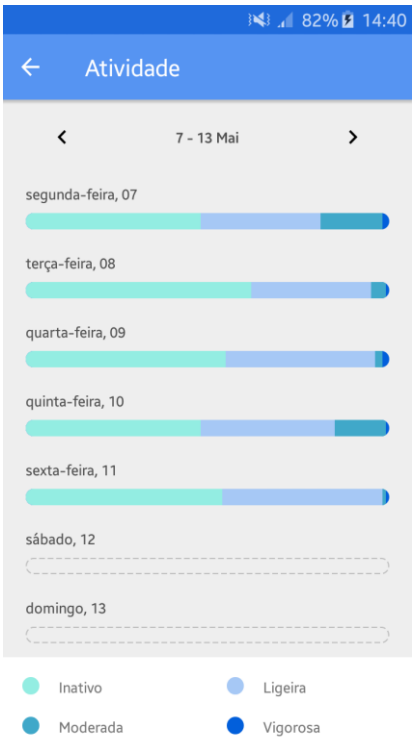

Image 7 - *Screenshot of the activity level screen (between 7th May and 13th May)*

In what comes to their sleeping records, while some participants would consult it when having an opportunity to rest during a night shift appeared, others would do it mainly at home. When ***checking the sleep records***, shift workers had a screen with new sleep records or not. If the system had detected sleeping periods (**Image 8**), shift workers would ***validate their records***. Those records could be confirmed if correct, edited if partially correct or deleted if they did not correspond to the reality. If records were confirmed, the system would display a plot with the total number of slept hours per week (**Image 9**).

When confirming the sleep records, shift workers would do it based on their memory, not being very accurate (mostly on the time that they fell asleep). One of the actions shift workers often had to do when validating their sleep records was to eliminate them, because the system was not very accurate and a lot of records did not correspond to the reality. When this happened, some workers would ***add themselves the real sleep periods***. However, other workers did not feel it was useful, so they would rather leave it empty.

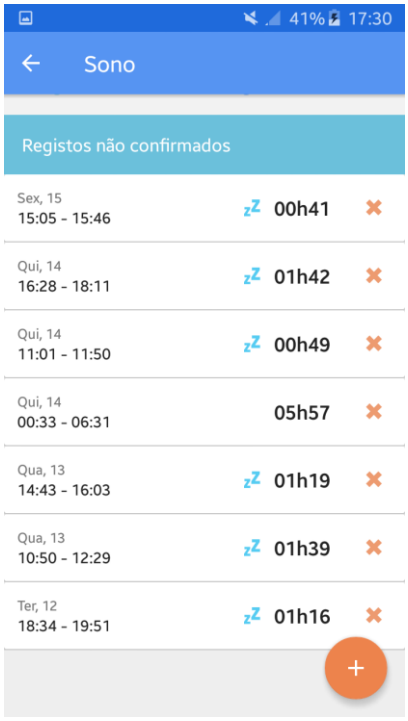

Image 8 - *Screenshot of the sleep records (between 12th April and 15th April)*

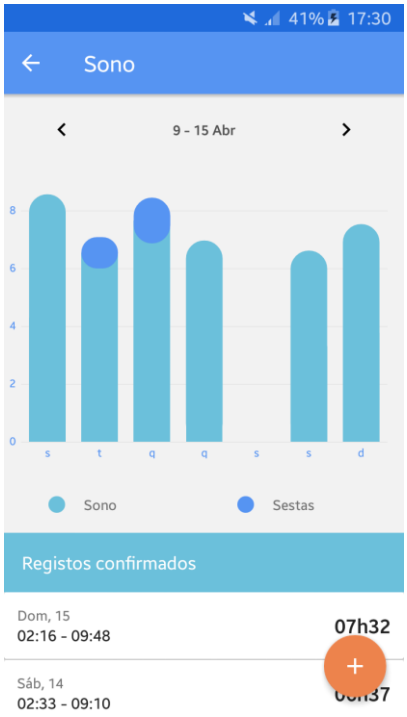

Image 9 - *Screenshot of the week plot that resulted from the validation of sleep records*

In regards of the moment where they used to check the sleep records, they did not have a pattern. Some workers would do it only when they were at a night shift, while others would do it at home after waking up, and another participant would even do it only once in a week at the weekends. There was not a standard moment where all the participants performed this task. Then, to keep their smart badge functioning, shift workers had to charge it. ***Charging the smart badge*** was something they did not need to do many times, as P08 tells us, satisfied:

> P08: *Very honestly, I charged it very few times... all this time I've been with it. (...) I tell you something: not to lie, if I charged that card 4 times it was a lot.* (Female, 49 years old, orderly)

This participant was realizing how few times she had charged the smart badge in 8 weeks, recalling the times when she did it. She was very pleased that the badge did not require many times of charging. If for this participant this was a great part of the system, for other participants it was very unclear knowing when to charge the badge as it did not provide any feedback on the percentage of battery. For this reason, when at home, most participants would ***leave the***

badge charging during the night, so that they would be sure that it would be fully charged. Sometimes, when in a break of a night shift, one participant used to take off the badge to place it over the charge.

The system had a technical problem during the pilot, where activity was not being recorded at some moments. One of the participants, who would always ***verify if the system was working*** when starting the working shift, noticed that this was happening because the application displayed a sign of the badge being disconnected. Because of this, the participant, who was very committed to collaborate, tried constantly to ***make the application work***, turning off and on the Bluetooth and, in last case, restarting his own mobile phone.

4.2.5. User experience evaluation

4.2.5.1. BARRIERS TO USE

During the pilot, participants experienced numerous barriers. After analysing those barriers, it was possible to define three main types. Those had to do with the system's design, reliability and system limitations. Within the design, most of the barriers had to do with the participants' difficulty to understand aspects of the application[10]. For example,

> P21: *I don't know what is… what you consider as vigorous activity and what you consider as active and that stuff, do you understand?* (Female, nurse, 49 years old)

This nurse was talking about the activity records and the fact that she does not know what level of effort corresponds to the categories in which the activity is classified. The activity screen shows one bar per working shift (**Image 9**). Each bar is filled with "inactive" once a working shift starts. As hours pass by, it redistributes the colours according to the type of activity a person is performing (**Table 5**). The application was designed to classify intensity of activities according to the compendium of physical activity, as the following table shows.

However, this categorization is not described in the application; there is not a description for the activity levels. Therefore, when one looks at it, one does not know what it means. It is only possible to see that someone had a certain amount of time inactive, a certain amount of time with light activity, moderate and vigorous. Moreover, equal levels of activity were recorded cumulatively to previous ones, which means that the activity recording is not separated by moments of occurrence.

[10] This difficulty is not a problem of the participants, but of the system's lack of usability.

Table 5 - *Activities and physical activity level* (Pereira, A., Nunes, F., 2018, p.2)

[11]

Activity	Activity Level
Laying on bed	Sedentary
Sitting (not moving)	Sedentary
Standing (not moving)	Sedentary
Organizing material on shelves	Light
Cleaning table	Light
Cleaning small object (smartphone)	Light
Typing on a computer	Light
Walking (free) on different directions	Moderate
Pushing person on wheelchair	Moderate
Walking on treadmill (4.5 km/h)	Moderate
Descending stairs	Moderate
Mopping floor	Moderate
Running on treadmill (6.5-8 km/h)	Vigorous
Climbing stairs (fast pace)	Vigorous

Because of these two aspects, all the participants complained about the activity records, saying that it was not very clear. According to at least two participants (P21, P24), it was important for them to know the specific moments where each activity level took place, instead of a proportion of a complete working shift for each activity level. This way, they would be able to attribute specific tasks to the different levels of activity and, therefore, become more aware of the time they spent with each one. One of their particular interests was to know how much time they spent doing records or even being able to justify less active periods.

This issue regarding the representation of the activity level also led participants to the feeling that records did not correspond to the reality.

On one side, participants felt that the "inactive" level of activity was entirely inaccurate:

> P21: *The inactive (...) on Saturday I did an afternoon and a night [shift]. It was a night almost always walking (...) however it isn't... if I have this [level of] activity... it does not correspond (...) I mean, if here says that it has been inactive on Saturday all this time... it is not true, right? (...) "Inactive" is standing still. Okay, it does not have nothing to do, it does not correspond. (...) For example, if I am bathing [a patient]... I am over there standing on the same place and... if the card doesn't move a lot, it doesn't show activity.* (Female, nurse, 49 years old)

[11] The *sedentary* activity level is what corresponds to the inactive level on the current system

Like this nurse was explaining, to be inactive is to stand still, which is something she does not agree to be true. Actually, all of the participants referred many times that they walk from one side to another and that it is difficult to stop for a while, except when they manage to get a break or when they are doing records on the computer. Hence, whether they have a lower level of activity or not, at least it does not match with the term "inactive", in their opinion, as it refers to no activity at all. So it would be a case to rethink about the nomenclature.

On the other side, when participants were analysing activity records, they would not perceive the amount of "inactive" as real. But it was just at a first glance. When this happened, participants were asked to reflect on which activities they performed on the shift they were doing by the moment of the interview, ending up realizing that the activity records were not that different from reality, like in the excerpt that follows in the next page.

This is a very good example of the participants' difficulty to read the activity bars, which influenced their perception on the correspondence to the reality. However, it also might be a sign of apprehension relatively to others getting the idea that they are not working for long periods of time. This is an alternative explanation for their initial resistance to accept the inactivity activity state.

Other problems within the system's design comprised usability and feedback issues. In terms of usability, some participants seem to be a little uncomfortable with technologies as they would struggle to move from any screen of the application to the dashboard (although they had an arrow to go back). In the same way, on the activity and sleep detail screens, participants could navigate backward to see previous weeks. These screens also had arrows to go back and forth. Nevertheless, some participants would not notice they could do it and, therefore, they did not know that they had records behind.

EXCERPT FROM THE SECOND INTERVIEW WITH P09

Researcher: Do you think [the activity records] are corresponding to the reality?

P09: No, because we have been walking here a lot, we have not been inactive here, I think that even at home and at least until eight o'clock we have a hard time walking. I think it's an agitated activity.

Researcher: But it [the system] does not register [data] at home, be aware of this.

P09: Okay, here it [the system] records [inactivity] because we have here one out of six hours… and it might match the reality… hmm… I have no idea. This part might correspond…

Researcher: Does all this bar, that appears here[12], meet what you know that [you have done]?

P09: No, I'm not inactive, no.

Researcher: Do not interpret this [part] as the beginning of the day and [the opposite side as] the end.

P09: Ah, ok. Then I don't agree that "inactive" has this much…

Researcher: [The system] counts every moment where you have been agitated and puts there the bar of the agitated. And it can grow more or less, depending on the time, you see? It is not ordered. I join these two [intervals of time], I count the time and put there in the end [for example].

P09: It's the sum of everything.

Researcher: So, in this case, you do not feel much correspondence with reality.

P09: No, because I'm not idle for so long.

Researcher: Can you imagine any explanation why it did not detect so much activity here? For so long?

P09: Well, here [at this hospital unit] is a more serene part. Maybe it's because we do not walk as much as I walk downstairs, I don't know… I did several office things, I was on the phone and I was taking some numbers to be able to call customers, maybe that is your justification.

Researcher: Precisely... then you have been doing here a lot of activity of…

P09: …office.

Researcher: Okay

P09: Not of movement

Researcher: Right

P09: That's it, and maybe it's that activity. (…) It can already correspond because I've been an hour and a half, two hours on the phone taking phone numbers and everything (…) today was more or less this… from this perspective, right, it actually corresponds, yeah.

[12] On the 24th July (**Annex G: Print screen of weekly activity records from participant #09**).

In terms of feedback, it were identified essentially two problems from the participants' interviews. One was regarding the smart badge battery; participants' did not have any information or notification that would tell them when they needed to charge the badge. This resulted in one of the activities described on the previous topic (**4.2.4.** *Performed activities when using the system*), about the participants' letting the badge charging the whole night.

Then, another aspect relates to the activity records. At least one shift worker (P21) did not understand that the system would only capture the activity if the calendar had the working shifts introduced. And another worker (P08), who had the calendar complete, asked if she had to do something for the system to start recording the activity every time she would start and finish working. These two cases showed that there was missing some feedback that could make it clear for the participants what was happening and what was expected of them to keep the system working. Other issues were about the participants' forgetting to do something, like introducing the shifts in the calendar or placing the badge on the chest. In these cases, the system would not record activity data.

All these aspects relate somehow to the application design, but there was also a problem with the badge's design.

> P09: *The only thing, as it [the badge] was heavy... I took off [the neck strap] and I only remained with the card [the badge] suspended. Because as it was heavy and the strap ended up, while bathing [a patient], falling, then I would only put the card and would only keep that. (...) It has this 'spring'*[13] *and formerly it had this strap. (...) I changed the strap and put this 'spring'. It holds like this. (...) Because with the strap it ended up hitting the client and I ended up putting it like this and this way it does not hit them.* (Female, orderly, 57 years old)

As we may read, the smart badge was not light enough to be suspended on the strap that workers usually wear. It was inconvenient not only for the worker, who was not so comfortable using the badge that would fall forward in some tasks, but also for the patients, who would be hit by it. Fortunately, the participant was able to find an alternative that solved this inconvenient. This shows that the badge's design is something that requires further development.

[13] ID badge clip

System's reliability

Another considered type of problems, identified through the participants' experience, was in regards of the system's reliability. Sleep records were not always accurate as they were false positives. And also, a lot of records were added by the participants, meaning that it did not identify them. Besides the lack of accuracy, the system also had a time where it incurred in errors that resulted in the loss of data, either validated or introduced by the participants. When a participant tried to introduce records again, he would not be able because the system would crash.

System's accuracy

Then, like sleep records, activity also failed sometimes. The system would not record some shifts and even with the ones it did, the participants complained that they were not matching the work they have performed. In this sense, investigation on activity records' accuracy is required. It is difficult to distinguish whether if recorded data is actually false or if workers have a wrong perception over their activity. Moreover, we should be aware that they are subject to the psychological wear, which the system cannot measure.

Worse than these two modules was the light exposure. This particular part of the system was not successful as it would mostly record 0% of light exposure, which cannot be true. It ended up being something the participants did not pay much attention as it would not provide any information.

System limitations

Finally, the last set of barriers identified had to do with things the participants missed in the system, having in account the things they had more information about. If we recall, in the beginning participants were interested in information about their sleeping needs and they wanted to know if the lights in their workplace were appropriated. However, as the system provided more information about sleep and activity, these were the aspects they ended up feeling more interested about. The sleep was well represented for them, but the activity fell behind their needs. Like already explained before, the activity bars lacked in their design, as it was prone to confusion when interpreting them. Hence, participants felt this part was missing the hours where each activity level occurred. P27 was even shocked when she realized she could not see the hours:

> P27: *Cristiana, what about the hours?! The periods (...) because without the hours we cannot understand very well. (...) Because like that we could have a perception "Look, in the morning I was more productive than at the middle of the afternoon." (...)* (Female, orderly, 51 years old)

P24 and P21 conclude this idea:

> P24: And if we had *[the activity bar] separated like we have in our 12-hour shift, if it had 12 different spaces, we would know that it fulfilled throughout the shift, right? And we would know that the dark blue [vigorous] activity was between this and that hours and the light blue [light activity] was between something… we would have a more effective idea of what productivity corresponds to… to what shift it belongs, right?* (Male, nurse, 52 years old)

> P21: *(…) also it would give us a little feedback to know how much time I am doing records.* (Female, nurse, 49 years old)

Having a record that enables shift workers identifying the moments where they have higher or lower activity is relevant for them. When asked about why that would be useful, P24 explained that it would be easier for him to compare the periods of activity and to identify what type of tasks he has done in each. He was saying that it would enable him to better know his workload during a shift, and to better understand when he is more and less active. This would be important, he explains, for the working schedule to be better distributed among shift workers. Being aware of his daily workload would be useful to understand if it is necessary to have more nurses at a same period of the day, so the moments with higher workload have more people. To this participant, the activity records would then represent a tool for him to support some opinions that he would like to bring forward to his chief nurse and to the hospital Nursing Directorate. This way, he could argue that some periods of the day require more nurses than usual as they have an "overloaded workload".

Once the activity bars represent a distribution of each activity level, shift workers find it little informative. Still within activity recording, an orderly mentioned that it would be better for her if the system could detect the working shifts, so she would not need to insert them in the calendar. For this participant, it was really demotivating the need of introducing things in the application; she would rather just consult it.

4.2.5.2 SYSTEM'S IMPACT ON SHIFT WORKERS' LIVES

Contrary to these unsuccessful experiences, and against the strong conviction shift workers had in regards of knowing their own resting habits, two participants (P09 and P24) were not only able to learn something from the Clockwork system, as they took some decisions to change what they considered that was not good for them. A male nurse, who called himself a "night owl", said that he was feeling bad about himself because he could see through the sleeping records that he was sleeping less time than what he expected. This nurse was used to keep himself awake until very late in the night, because he appreciated a lot having some leisure time; it was very important to him. Nevertheless, when he realized he slept so few hours, he decided that that had to change. He opted to have less hours of self-satisfaction to have more resting time. According to him, it was the only possibility, as work could not change. Despite the will to change, he admitted it was difficult to do it, because some habits are difficult to break immediately. Therefore, he explained that there were some nights where he still got to bed a little late because he still needed to have his leisure activities. For him, a leisure moment requires a quiet place, which only happens by the night time, in his words. Nevertheless, he was trying to change as time passed by.

With so many barriers to use, there were little expectations that the system would have any impact on shift workers' lives. In fact, this was true for three participants, particularly to one of them (P27). Despite two of them have learned a bit more about their sleeping habits (P08 and P21), they said that they could not change anything, which made it useless. The worst case was of a participant who was completely demotivated to use the system, because it was like a burden for her (P27). In this case, the need to introduce information in the system, such as putting the working shifts and selecting them on the calendar was something she preferred it was not necessary. The worker even suggested that the system should be able to detect the working shifts automatically. Moreover, the system's lack of accuracy was also something that made it very useless, as the worker would not insert the records for herself.

5. Discussion

This chapter discusses the results of this work. It will start by providing a reflection on the results from the interviews, contrasting with existing work. Then, the contribution towards the customer experience framework is explained.

5.1 Research on Shift Work

The findings presented above show that working in shifts in healthcare is full of daily challenges, requiring a constant effort of managing one's sleep-wake routines and food patterns, like pointed by the literature (Novak and Auvil-Novak, 1996; Costa, 1997; Pisarski, Bohle and Callan, 1998). Being a shift worker also involves some emotional coping strategies to face with the many inconvenient from working in shifts (Pisarski, Bohle and Callan, 1998). What the literature does not make so clear is how this type of working arrangements affect shift workers' daily life, which was complemented with this work.

Working in shifts has some advantages, like the flexibility of being free at atypical hours for longer times, enabling workers to be with their children and taking care of personal responsibilities. At the professional level, it gives shift workers the possibility of better accompanying patients, enabling them to be more efficient on their interventions. However, these positive aspects entail some inconveniences. Sleep and food patterns are not the only aspects being affected (Novak and Auvil-Novak, 1996; Costa, 1997). Besides what has been described in the literature, working in shifts requires an effort to balance one's personal and professional life and one's own health, which can comprise:

- **Coordinating and adapting schedules:** Shift workers are constantly managing their daily life with their families, checking what is going to be their schedules to coordinate with house responsibilities and children. Other events, like family gatherings or friends' meetings, are also things they try to be present at by asking for a shift exchange between them and their work colleagues. However, one can ask for a shift change, just as one can be asked to do so. Hence, what represents a benefit in a way, may also represent an inconvenient sooner or later. Besides shift workers' own interests, the hospital also has its demands. When there is unexpected service or missing colleagues, shift workers may be called to help out their service.

- **Activities to promote sleep:** Other than managing the best moment to sleep or the duration of it, this work enabled to understand that shift workers also perform activities that help them become calmer. While previous work reflected on shift workers' attitude

towards the difficulty in getting sleep (Novak and Auvil-Novak, 1996), this work complemented the existing knowledge by adding activities they perform to help becoming sleepy. The most mentioned practices were taking a shower, going to the gymnasium or activities that required their attention, like reading or watching a movie.

- **Managing tasks throughout a working shift:** Part of the shift workers' experience is also the need of managing tasks to not fall asleep in their job. The way shift workers manage sleepiness comprise food strategies (Novak and Auvil-Novak, 1996; NICE, 2013), entertainment and work planning. The literature had already pointed out the food patterns of shift workers, but in this work, it was possible to identify two other ways of keeping oneself alert. Besides little snacks and caffeine-related products shift workers also try to keep themselves entertained with reading, videos or movies when they have a downtime. But if they want to avoid having long breaks, they manage their tasks throughout the night, so that they always have something to do.

- **Managing to get a break for a nap:** While some workers have strategies to keep themselves awake (Novak and Auvil-Novak, 1996), others do not mind about taking a nap when everything is done. This way, they try to do all their tasks in a row, so there remains some time in the end for them to rest. Although workers try to sleep during a working shift, the findings from this study revealed that shift workers cannot have a deep sleep as they are in an alert state, because of feeling afraid that someone will need them, and they will not make it in time.

5.2 CX and SD contribution

Regarding the customer experience framework and service design approach, it was used a customer journey map (**Image 10**) to help visualize the journey of a shift worker when trying to manage his/her sleep-wake routine. Although that consists on a very clear and easy to read information about shift workers journey, it was very difficult to apply other tools to the studied context. The major discussion to bring with this master thesis is the need for further research and application of customer experience frameworks to an employee-based experience. Existing literature focus on dyads between customers and service providers, like reviewed on the literature chapter, while in this research project, the "customer" was an employee who needed insights on how to better make decisions about his/her own health, by better managing sleep-wake routines and strategies to copy with sleepiness at work. The main difficulty in this work

was to relate shift workers' path to a perspective of touchpoints, where a service provider offers some good or service that answers to the customer needs. Instead, shift workers struggle with many problems:

- Knowing best moments to sleep before and after a working shift, according to the type of shift,
- Knowing best practices to keep alertness in their workplace so that sleep after work is not compromised,
- Knowing the amount of time they should sleep in each sleep or nap and
- Have control over their working hours to be able to argue with their superiors.

These needs may be through the use of Technology, namely, bearing in mind the fact that despite the numerous barriers, the system enabled two participants – out of five – to become more conscious of their habits and decide something about it. However, how to apply Service Design methods to shape technology was particularly challenging to me, which resulted in a poor application of that body of knowledge.

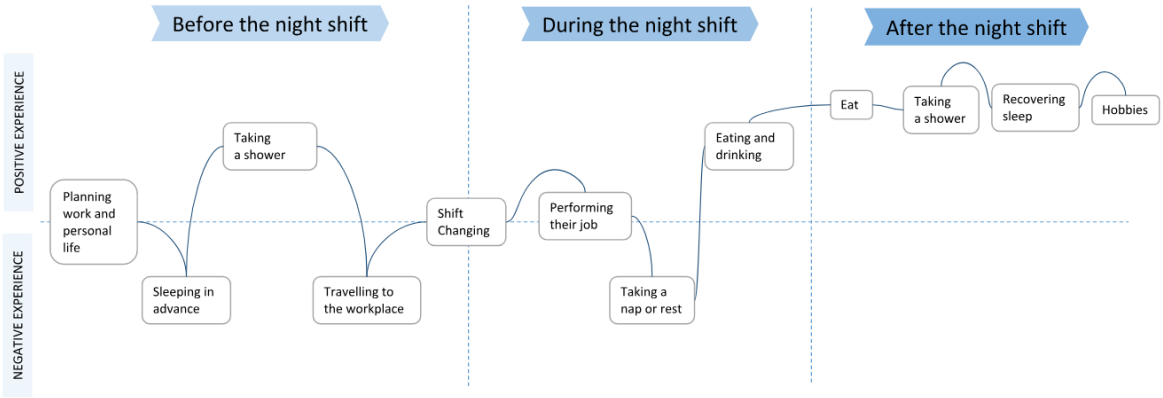

Image 10 - *Shift worker journey map*

6. Conclusions and future research

Shift work is nowadays a prevalent work arrangement in society and its harmful effects are acknowledged worldwide (2.2 Sleep disruption and circadian rhythms, 2.3 Effects on health and well-being, 2.4 Effects on private and social life). A need for a different approach to help shift workers minimizing the consequences of their work schedules is clear (2.5.8 Gaps and Future Directions), which was tested in this research. Results showed that, despite being in its very early stage of development, the Clockwork system has the potential of helping shift workers improve their lives, by enabling them to make decisions over their own collected data (4.2.5.2 System's impact on shift workers' lives). To accomplish better results, it is necessary to eliminate the identified barriers (4.2.5.1. Barriers to use) and to add value through co-creation. Future work should rely on exploring the best fit of Multilevel Service Design method to improve the shift workers' experience, by applying its process stages (2.7.1) to the research study process.

In the beginning of this work, two main research questions were raised:

RQ1: How do shift workers manage their shift work?

Shift workers manage their shift work by trying to balance their health, their personal life and their professional life. Shift workers' challenges doing this comprise especially two different aspects: the difficulty of coordinating the work demands with their personal commitments and struggle of keeping themselves alert when doing long or night shifts.

Regarding their atypical working schedules, the fact that shifts vary across the weeks, hampers establishing well defined routines, which impacts their familiar and social relationships and their sleep habits. To cope with these issues, shift workers try to constantly adapt to work duties and family needs, by sharing their agenda both at home and at work and making decisions on what are the best moments to sleep. However, most of participants do not do this in a systematized way. Rather, they do it according to what they feel, as in, their sense of tiredness. Regarding the struggle to keep themselves awake at work, shift workers either try to rest, even if alert, or try to maintain alertness by eating, drinking coffee or entertaining with something.

RQ2: How do shift workers experience the Clockwork system?

From the professionals' point of view, the Clockwork system seemed very useless until a given time, as participants were confident that they knew very well their resting needs and habits. Therefore, it was like the system would not give them any news. Despite not believing the system could enable any change, shift workers expected that the system could provide them

information about their effort while working, as well as some tips of when they should have a break. Moreover, lightning conditions seemed to be something they were curious, despite believing that it could not be possible to change.

As time passed by and shift workers used the application, they became more interested in in their sleep hours and their physical activity level. Despite the lack of accuracy of the system, what we can conclude is that even if the sleep records were added by the participants themselves, the system provided them a systematized information that they did not have before. Although they believed they knew themselves very well, two participants out of five could learn from their sleep records and perceive that they actually slept less than what they expected.

In terms of their daily life, the system did not introduce any negative impact, except as reported by one participant, whose Smart Badge would fall over the patients because of its slightly lighter weight (when compared to the regular ID badge cases). Other than this, charging the sensor was not something participants complained, except the fact that they did not know when to charge the Badge. Contrary to this issue, one participant was very surprised when she realized that she had only charged the Smart Badge 4 times in 2 months.

The system did not cause impact in the majority of the participants. However, considering that with so many barriers it was still able to benefit two participants in such a small sample, is something to consider, as it shows the system has room for improvement and has potential to provide better experiences to shift workers.

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Annex A: Informed Consent

CONSENTIMENTO INFORMADO

QUAL O CONTEXTO DESTE ESTUDO?

O projecto ClockWork – dos parceiros Associação Fraunhofer Portugal Research (Portugal), Grado Zero e AbAcus (Italia), BCB (Espanha), RKTech (Hungria), KOHS (Austria), e José de Mello Saúde (Portugal) – tem como objetivo desenvolver um sistema para suportar os trabalhadores que fazem turnos. Através de dispositivos móveis e sensores o Clockwork irá recolher parâmetros da vida diária e profissional dos trabalhadores, e apoiar a auto-reflexão e auto-consciencialização dos mesmos.

O estudo envolve a utilização dos seguintes dispositivos:

- "**Smart Badge**" - Crachá com sensores que o participante utilizará diariamente sobre a roupa;
- "**Smartphone App**" - Aplicação móvel a instalar no smartphone do participante que permite visualizar os dados recolhidos pelo crachá;
- "**Clockwork Box**" - Sistema de monitorização de condições ambientais de um espaço (luz, ruído, temperatura);

QUAL O OBJECTIVO DESTE ESTUDO?

Neste estudo avaliaremos a exequibilidade, usabilidade, e aceitação do sistema desenvolvido com os trabalhadores por turnos.

TENHO DE PARTICIPAR NO ESTUDO?

Depende de si decidir se quer ou não participar no estudo. Se decidir participar, deverá assinar este Consentimento Informado. É sempre livre de desistir do estudo em qualquer altura, sem incorrer em qualquer tipo de consequência.

O QUE TENHO DE FAZER?

Se aceitar participar, irá utilizar o Clockwork durante dois meses (de 3 de Abril a 3 de Junho). Deverá substituir o seu crachá pelo Smart Badge, e utilizar a Smartphone app para confirmar os seus períodos de sono. Pediremos ainda que coloque a Clockwork Box numa sala onde passe algum tempo do seu trabalho, de modo a que monitorize as condições desse espaço. A sua participação no estudo prevê ainda a resposta a um conjunto de questionários antes de começar o estudo e no momento de término, assim como a participação em entrevistas informais regulares.

A seguinte tabela discrimina as ações necessárias do seu lado e a recorrência com que ocorrerão:

Ação	**Recorrência**
Preenchimento de questionários	2 vezes: pré- e pós- intervenção
Colocação da **Clockwork Box** em sala que será monitorizada por 2 meses	1 vez: início do estudo
Registo na **Smartphone App** dos horários dos turnos para o mês a iniciar	2 vezes: mensal
Confirmação na **Smartphone App** das horas dormidas	Diária
Utilização do **Smart Badge** durante os turnos de trabalho	A cada turno
Participação em entrevistas semanais/quinzenais para perceber como está a ser a sua experiência com o sistema	Semanal/quinzenal

A equipa de investigadores do projeto estará disponível em qualquer momento para esclarecimento de questões que tenha ou qualquer apoio que necessite na utilização/parametrização dos dispositivos.

De forma a salvaguardar e proteger a sua informação, os dados recolhidos vai ser tratados de forma anónima e não serão acedidos por terceiros não autorizados. Seis meses depois do fim do projeto, a informação recolhida nestes questionários vai ser destruída permanentemente. O projeto vai seguir a nova Lei Geral de Proteção de Dados da União Europeia, a Carta dos Direitos Fundamentais da União Europeia e a Declaração de Helsínquia. A participação no estudo não apresenta nenhum risco para a integridade física e mental dos participantes, não envolve qualquer dano material e não envolve qualquer forma de pagamento.

TENHO BENEFÍCIOS EM PARTICIPAR NO ESTUDO?

Este estudo irá permitir o desenvolvimento de uma solução de melhoria das condições de vida dos trabalhadores com turnos noturnos, pelo que poderão surgir benefícios imediatos para si. A informação que será obtida deste estudo poderá também ajudar a comunidade médica e científica a perceber qual a melhor forma de apoiar este tipo de trabalhadores dos doentes, ajudando-os a minimizar as consequências negativas provocadas pela realização de turnos noturnos.

Agradecemos o seu contributo, fundamental para a nossa investigação!

O participante:

Declaro ter lido e compreendido este documento, bem como as informações verbais fornecidas e aceito participar nesta investigação. Permito a utilização dos dados que forneço de forma voluntária, para os fins descritos. Declaro ainda que autorizo a publicação de imagens recolhidas no âmbito da participação no estudo, nos diversos meios de comunicação social e em publicações científicas e conferências ou outro tipo de evento científico ou de divulgação do projeto.

Nome do participante: _____

Assinatura do participante: _____

Data ___ / ___ / _____

Investigador responsável:

Nome: Francisco Nunes

Assinatura: _____Data ___ / ___ / _____

Telefone: 220 430 300

E-mail: francisco.nunes@fraunhofer.pt

ESTE DOCUMENTO É FEITO EM DUPLICADO: UM PARA A/O PARTICIPANTE E UM PARA A/O INVESTIGADOR/A

Annex B: Contextual interview

TRABALHO

- Descreva por favor os seus dias típicos de trabalho
    - Tipos de turnos que faz
    - Com que frequência acontecem
    - Onde acontecem
    - Que tipo de tarefas acontecem em cada um
    - São todos no mesmo empregador?
    - Como é informada dos turnos?
- Há quanto tempo trabalha por turnos?
- Trabalhar por turnos foi uma escolha?

IMPACTO

- Trabalhar por turnos ou em horário diurno é igual para o corpo?
- Quais são as consequências físicas e mentais?
- E no global? Quais são os impactos de trabalhar por turnos?
- Pode-se fazer alguma coisa para minimizar o impacto dos turnos?
- Qual é o impacto do trabalho ao computador?

PROBLEMAS/DESAFIOS:

- Quais são as maiores dificuldades práticas de trabalhar por turnos?
- Trabalha-se com a mesma qualidade a qualquer altura do dia?
- Vantagens do trabalho por turnos?

DESCANSO:

- Dorme-se bem depois de uma noite de trabalho?
- É normal acordar sem querer?
- Usa alguma estratégia para adormecer melhor?
- E como é que se acorda a tempo?
- Usa algum tipo de medicamento para ajudar a dormir?

RELAÇÕES:

- Qual é o efeito do trabalho por turnos nas relações com outras pessoas?
- As pessoas em seu redor fizeram algum tipo de adaptação ao seu horário?

PEDIDOS:

- Podia mandar-nos fotografias do seu quarto mostrando as luzes que tem?

Annex C: Interview outline when starting to use the Clockwork system

Introdução: Bom dia/Boa tarde, o meu nome é Cristiana e estou a fazer uma avaliação qualitativa do sistema desenvolvido pela Fraunhofer para perceber qual é que tem sido o impacto da utilização do mesmo. Por isso, gostaria de lhe perguntar como é que tem sido a sua experiência. Posso colocar-lhe algumas questões?

1. Um dos principais problemas reportados pelos seus colegas foram problemas de sono. Também costuma ter problemas de sono?
2. Costuma lembrar-se das horas que dormiu? Como é que faz para saber se anda a dormir menos?
3. Depois de ter ouvido a explicação sobre como funciona o sistema e o objectivo deste, a quem acha que o sistema se destina? E o/a _____ é uma dessas pessoas?
4. O que é que espera do sistema Clockwork? Tem alguma expectativa em particular?
5. Como é que acha que a utilização do sistema vai afectar o seu dia-a-dia?
6. Tem alguma reserva / alguma preocupação relativamente ao uso do Clockwork?

Annex D: Interview outline while using the Clockwork system

Introdução: Agora que já teve oportunidade de experimentar o sistema durante duas semanas, gostava de perceber como é que está a ser a sua experiência de utilização. Posso colocar-lhe algumas questões?

1. Em que momentos do dia tem usado a aplicação?
   (consoante a resposta, colocar **a.** ou **b.**)
   - **a.** Por exemplo, ontem, quando é que usou a aplicação? E o que o/a fez usar a aplicação nessa altura? Ter pegado no telemóvel? Ver o lembrete da aplicação?
   - **b.** Porquê que prefere usar a aplicação *em casa* / *no trabalho*?
2. Existe algum motivo em especial para não usar quando está *em casa* / *no trabalho*?
3. Qual é que tem sido o impacto da utilização da aplicação a nível profissional?
4. E a nível familiar, há alguma mudança que tenha a registar?
5. Lembra-se de alguma coisa que tenha sido particularmente interessante para si até agora?
   - **a.** Isso alterou a forma como tem vindo a usar o sistema ou a forma como pensa acerca da sua utilidade?
6. Consegue dizer-me algo que tenha aprendido ou que se tenha apercebido através da utilização do sistema?
7. Qual é que tem sido o impacto do sistema? De que forma é que afecta (positiva ou negativamente) o seu dia-a-dia?
8. Tem tido algum feedback dos seus colegas? Alguém nota que está a usar esse badge? Que opiniões é que partilhavam?
9. Alguma outra funcionalidade ou aspecto de que sinta falta?
10. Há algum incómodo ou inconveniente em particular decorrente do uso da aplicação?

Annex E: Final interview outline

Introdução: Depois de ter estado 8 semanas a usar o sistema de Clockwork, gostávamos agora de perceber o impacto global que o seu uso possa ter criado e que só terá sido possível devido à sua colaboração, ao usá-lo, que mais uma vez agradecemos. Posso então colocar-lhe algumas questões?

1. Primeiro gostaria de começar pela sua opinião mais imediata em relação ao piloto. O que é que funciona bem no sistema e o que é que podia ser melhorado?
2. Diga-nos o que é para si esta aplicação.
3. Imagine que eu era uma pessoa que não conhecia esta aplicação e que lhe pedi que ma mostrasse. Pode mostrar-me a aplicação e ir explicando verbalmente o que está a ver e para que serve?
4. Lembra-se de alguma coisa que tenha sido particularmente interessante para si?
    a. Acha que isso alterou a forma como usou o sistema ou a forma como pensa acerca da sua utilidade?
5. Conte-nos como é que foi sendo a sua utilização da aplicação.
    a. Por exemplo, em relação aos registos de sono: descreva como é que foram pra si, em termos de correspondência com a realidade. (Lembra-se se os horários de sono que a aplicação lhe indicava costumavam estar certos na maior parte das vezes ou errados?)
        i. De que forma é que isso alterou a forma como interagia com a aplicação? Que consequências é que isso tinha?
    b. (Nos casos em que o participante introduziu vários registos de sono)
        i. Dos registos que introduziu, fazia-lo apenas nos dias em que tinha turno ou independente do dia?
        ii. Teve vários registos de sono introduzidos por si. Valia a pena registá-los? Qual é que era o benefício disso?
    c. (Nos casos em que o participante (quase) não introduziu registos de sono)
    Apesar de não ter muitos registos de sono detectados pelo sistema confirmados, também não introduziu manualmente os verdadeiros horários em que dormiu. Porquê?
    d. O que é que a/o fazia ir à aplicação verificar (e/ou introduzir) os registos de sono? (Lembrava-se? Via alguma coisa no telemóvel?)

6. Consegue dizer-me se identificou alguma altura em específico do seu dia em que costumava mais registos de sono correspondentes à realidade? E em que alturas tinha mais registos que não eram correctos?

7. Em relação à actividade, que apontamentos é que tem a fazer? Alguns colegas ao longo do piloto mencionaram que era importante perceber de que forma é que o sistema captava a sua actividade ou em que é que consiste cada um dos níveis de actividade (inactivo, ligeira, moderada, vigorosa). Sentiu esta necessidade também? Porquê?

8. Consegue dizer-me algo que tenha aprendido ou que se tenha apercebido através da utilização do sistema?

- **a.** Em relação à noção que tinha inicialmente das horas que dormia e do esforço que fazia no trabalho, a sua percepção mudou com a utilização do sistema ou considera que não houve novidade alguma?

9. Alguém notou que estava a usar algo diferente? Alguém lhe fez algum comentário? (Caso sim, como é que se sentiu em relação a isso? Algum tipo de constrangimento?)

10. Considera que o sistema teve algum impacto na sua vida pessoal ou profissional? Mudou alguma coisa nos seus hábitos/rotinas?

11. Porquê que não alterou nada/alterou?

12. No seu entender, este sistema pode alterar a forma como o trabalho é organizado? Como/Porquê? E a nível familiar?

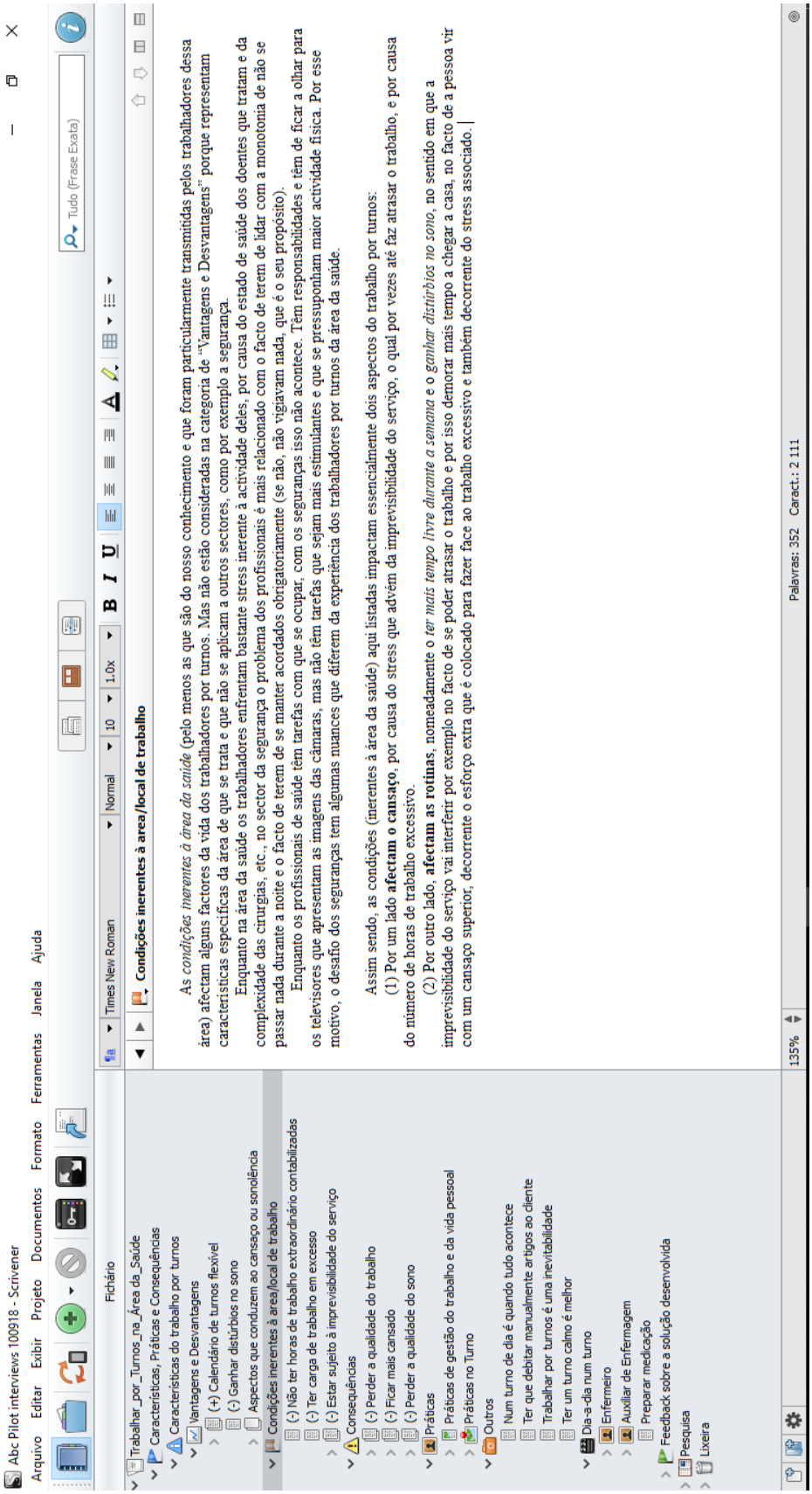
13. Alguma outra funcionalidade ou aspecto de que tivesse sentido falta ou que gostasse que a aplicação contemplasse?

14. Houve algum incómodo ou inconveniente em particular ao longo desta experiência? Diria que havia algum aspecto que o/a desencorajava de usar a aplicação?

15. O que é que acharia se a CUF decidisse fornecer este sistema a todos os profissionais?

16. No início desta entrevista, tinha dito que esta aplicação é para …….
No seu entender, os propósitos deste sistema são compatíveis com a cultura organizacional da CUF?

Annex F: Print screen of one memo within Scrivener software



Annex G: Print screen of weekly activity records from participant #09